



New and Rare Inventions
of

WATER-WORKS

Shewing the Easiest waies
to RAISE WATER higher
then the SPRING.

By which Invention

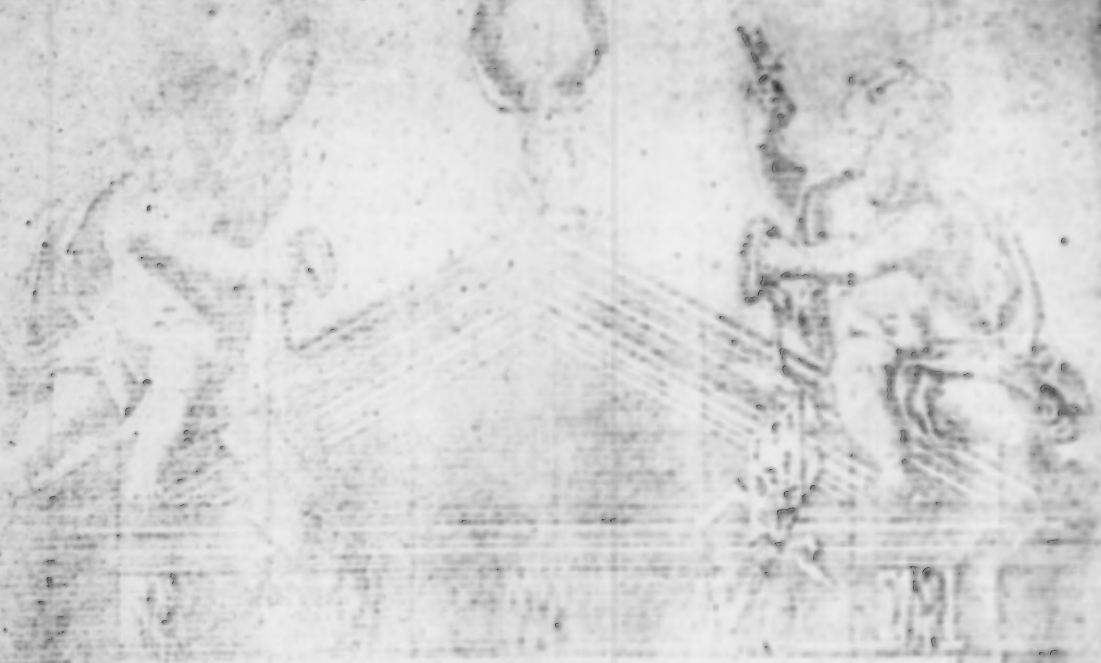
The PERPETUAL MOTION is proposed
Many hard Labours performed
And Varieties of Motions and
Sounds Produced

*A Work both Useful Profitable and Delightful for all
sorts of People.*

*First Written in French by J. S. S. A. K. & C. A. U. S.
a late Famous Engineer: And now Translated
into English by John Leake.*

LONDON.

*Printed by Joseph Moxon: and Sold at his
Shop in Corn-hill, at the Sign of Atlas, 1699.*



New and Rare Inventions

HYPER-HORSE
Showing off 4 class wares
to 6 ft 11 in high
than the SPIDER

The above invention
The Hyper-Horse is a
thing that is not
but a horse of a different
kind, and is not
a horse of a different
kind, and is not
a horse of a different
kind, and is not

1870
Patented by John Brown
of New York



THE PREFACE.

Because *The Raising of Water* *beigher then the Spring* (after the way principally intended in this work) seems to be opposite to the common received Opinion of all times, I have thought it not only sufficient to teach the Construction of the Engin proper thereto, but also (for more ample satisfaction) to premise certain Propositions to precede, in place of Principles; onely to make you understand the Effect of that Motion, by the Cause thereof; that so the way may be more accessible to the other *Phneumatike* Inventions; viz. [*Engins moving by the force of Air.*] To come to which, it must first be considered that all the *Elements* whether simple or mixt, have two principal motions, viz. *Natural* and *Accidental*.

The *Natural motion* is that whereby each *Element* searcheth and draweth it self towards the place assigned thereto by the Divine Providence in the Creation.

The *Accidental motion* is that which is moved by any outward Force, different from the First. Now although divers things seem to move contrary to their order,

B

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B

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The Preface.

without any *external* agitation: yet the reason is, that their contrary motion is caused, to hinder some other greater Accident. As for example, It shall be shewn that the *Water* to shun Vacuity, mounteth contrary to the ordinary Course thereof; because Vacuity is more repugnant to Nature then the contrary motion of that *Element*: as shall be seen by the principle propositions, which serve as a foundation of this Invention; which are founded upon this principle of Nature, *That there can be no Vacuity in the Elementary Sphear*, whereof the *Earth* and *Water* do supply the inferiour part, and the *Fire* and *Air* (which encompass them) the superiour part; and each of them are said *To be heavy or light, according as naturally they are near or further from the Center*; But in these four it will be necessary to have a regard as well to certain things whereof the *Air* and *Water* are capable, as to those wherein they cannot suffer Accident: as the *Water* which although it may be extended by the intermixture of *Air*, or attenuated and converted into *Air* by the means of Heat, which resolves it; yet nevertheless it cannot be prest, that is to say, that a certain quantity
of

The Preface.

of *Water* cannot be forced by compression to be contained in less space than its *Natural* extension: and the *Air* on the contrary may be restrained and put up, being prest; or rarified and extended, being moved beyond the other accidents whereof it is capable. These things shall hereafter be Demonstrated by Propositions founded upon *Experience*; which I have thought to be more convenient for this purpose than to involve the Reader in a Labyrinth of *Geometrical* Propositions; which (although most exact) yet are not altogether pertinent for Instructions in this Subject. As for example, If we should build upon this Rule of *Archimedes*, *That the Superficies of the Water is Spherical (when it is not moved)* which Superficies hath for its Center that of the whole Earth; there will follow a Subjection that we must hold in the Demonstrations; *viz.* That the Superficies of the *Water* is Circular, which (in the like case as is that whereof we speak) is esteemed plain of every one; and that, First, Because the difference is undescernable: and Secondly, Because it cannot make a defect in any Operation whatsoever; (a liberty therefore which is not permitted in the *Mathematics*.)

The Preface.

ticks.) That therefore, with other reasons have moved me to omit those demonstrations which seem to me to be too punctual for this purpose.

Note also that when I speak of *Water*, I mean *Water* equally heavy, without making any difference, although in case of necessity there must be had a regard thereto; chiefly if the difference be such as in the *Waters* of certain Rivers whereof *Plinie* speaketh, wherein nothing will sink to the bottom; as in the *Water* of the Lake *Alphaltite*, and in the *Water* of *Arethuse* which runs towards *Siractuse*, and that because of their extream weight, which returns heavy things to the top, as *Quick Silver* doth the Mettal, which sink not in it (although it be liquid) because it is more weighty. And in this we must make a distinction, that Mettals and heavy Solids sink in *Water* according to the figure they have: For *Copper*, *Silver*, and *Gold* sinks not in ordinary *Water*, if it be beaten out in plates or thin leaves: but if it be contracted into a more solid form it sinks forthwith to the bottom. But these and the like things I shall treat of in a Commentary upon the books of *Archimedes*, concerning *Weights*, and *Things sinking in Water*.

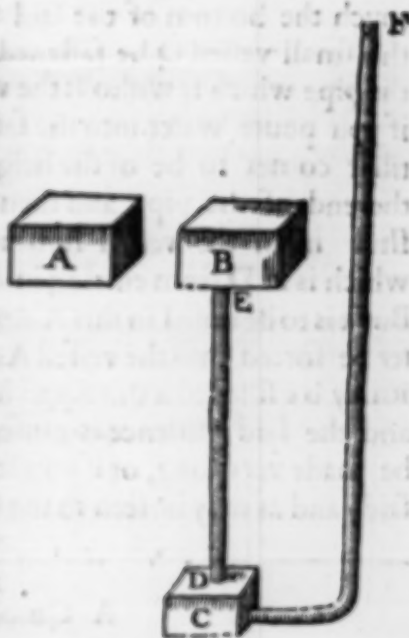


The Theorie of the Conduct of WATER.

PROPOSITION. 1.

The aire may be prest, but not the Water.

To give an example whereof, let there be two vessels A and B, of one form, matter and bignesse, the which let be full of Water, it is most certain that in either of those vessels the Water cannot be prest, so as the one of those vessels may containe the least part that may be more then the other: but when they are only full of *Aire*, I say that the said *Aire* may be prest, and one of those vessels may containe more then the other: which shalbe thus Demonstrated. Let the said vessels A and B be made very close on all parts, and at the bottom of the vessell B let there be a small hole E, to which the pipe E D is fastened, the other end thereof D is fastened to the upper part of the vessell C, the which is also made very close one every side, and containing about a third part of the vessell B, and to make the Water enter therein with force, it will be necessary to fasten the pipe F neer to the bottom of the vessell C, the which shall be made as high as may be, that it may give so much the more violence to the Water, the which entering the small vessell C, shall make the *Aire* that is therein to ascend into the vessell B, the which shall containe more *Aire* then A by the quantiry which was in C, and so the *Aire* shall be prest in the said vessell B, the which may be seen if you make a small hole in the said vessell, by the which the said *Aire* shall come forth with violence. But if you



2 The Theoric of the Conduct of Water.

pierce the vessell A there will not bee the same effect, because in it the *Aire* is not prest. But it is here to be Observed, that although the *Aire* may be prest, it is but only to a certain degree, which is about a third part: and for proof thereof, If the vessell C were as great as B, it were imposible that the said vessell should be filled with water, but that the *Aire* shall often break forth, and that because B is not capable to contain so much *Aire* therefore let it be held that the *Aire* may be prest in a close vessell to a certain degree. There is another way to force the water with violence into the small vessell, by the means of a Seringe, as in the second Figure.

PROP. 2

The water cannot enter into a vessell, but there must come forth as much Aire, except the water be sent in by force.

TO Demonstrate this, let there be a vessell as A, and let the pipe X be fastned in the cover thereof, so that it may neer touch the bottom of the said vessell, and let the small vessell D be fastned to that end of the pipe which is without the vessell: Then if you poure water into the said vessell A untill it comes to be of the height V, which is the end of the pipe, and then the *Aire* being shut in in the vessell A, hinders the water which is in D from entering into the vessell A. But it is to be noted in this Rule, that if the water be forced into the vessell A with violence, it may be filled to a third part or thereabouts, and the said violence is caused if the pipe X be made very long, or if you force the water in with a Seringe, as hath been said; and as may be seen in the second figure.



A Corollarie. PROP. 3.

It followes by the contrary reason that if a vessell be full of water it cannot be emptied so that the Aire shall not enter therein.

AS let the vessell or Vial D be proposed, which let be full of water, and let it be reversed, so as the mouth or neck may touch the water, which shall be set under it in a vessell; it is certain that although the mouth of the said Vial be downwards, no water shall run out, because the *Aire* cannot enter to supply the place of the water that should run out.



PROP.

PROP. 4.
There can be no vacuity.

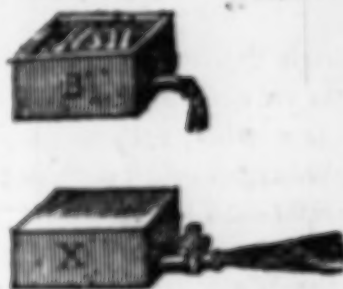
THis is that which hath been said in the Preface: the proof whereof may be gathered from the foregoing *Carallerie*, and divers other examples, whereof here is one: If you have a Copper pipe B, whereof the end C is in the water, and let the other end D be open, to the end that the Pestle A may be put therein, which shall be like to those which are used for Pumps and Forcers of water, and that the said end A, well invironed with leather, to the end that putting water in E it may not run through to B, then if A be raised to the point F, the water X which is levell with the point C, shall ascend to B, to supply so much place as is between A and F, so the water ascends higher then the levell, that there should be no void place left in B.



PROP. 5

If the Air be prest in a vessell wherein there is water, and that you give it passage by some pipe, the said water shall come forth with violence.

If the Air be prest in the vessell X, (let it be by means of a Sringe or by a pipe, as hath been said before,) it is certain that then when the water hath passage, it comes with a great deale more force then if it came forth from an open vessell, as B,

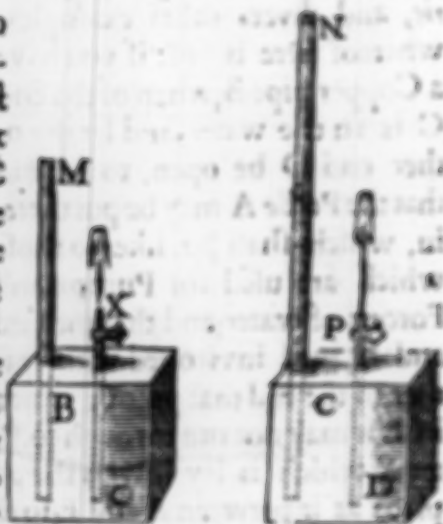


4 The Theoric of the Conduct of Water.

PROP. 6.

If the water Descends with violence into two equall vessels, there shall enter more water into that vessell where the water Descends from the highest place, and the Aire shall be more prest therein, and there shall be the same rate or proportion between the quantity of water contained in those vessells, as there is between the heights from whence the Water hath descended.

Let there be two vessells B and C, to which the water descends with violence by the pipes M and N, the longest of which is N, From whence it follows that there enters more Water in the vessell C then in B, and there is the same rate of the Water D to the Water O, as there is of the length of the pipe N, to the length of the pipe M. And it also follows from hence, that in the vessell C, where there is more Water, the Air shall be more prest then in B, and the effects thereof may be seen by the small pipes P and X, of the which two P casts the water highest, because the Air is more prest in the vessell C, then in the vessell B, in the same manner as before wee may proportion the Aire of the two vessells to the heights of the Water springing forth by the small pipes P and X, the which ought to be equall.



PROP. 7.

All heavie things whatsoever weigh more in the Air then in the Water.

Although that every heavie body hath alwaies in its self its proper weight, yet nevertheless they are also considered diversly, according to the place where they are placed, as it is certain that wood weighs nothing in the water, because it doth not descend towards the center of the Earth, which is proper to all heavie things, But if it be in the Air, it falls towards its center with weight: wherefore wee may say that it weighs more in the Air then in the Water: and so wee may say of all Bodies, although they are heavier then the Water, for although they fall towards their center of gravity in the Water, yet it is not with such swiftnes. It is not necessary to shew here by what quantity the said heaviness is more weighty in the Air then in the Water, sending the Curious to the Books of Archimedes, concerning things falling in the Water: where it is demonstrated that heavy things weigh more in the Air then in the Water, by the quantity of Water, which is equall to them.

A Corollarie

The Theoric of the Conduct of Water. 5

A Corollarie.

It is here to be Observed that Waters are of diverse weights, and they say that on the Territories of Cara in Spain, there be two fountaines, in the one of which divers things being put sink to the bottom, the which being put in the other, float at top. They report the same thing of the Lake of Sodom, and of the fountaine of Arethus. The which effect comes to passe by reason of the weight of the Water: and from hence wee may infer, that one and the same thing weighs more in lighter Water, then in heavier Water.

PROP. 8.

Water weighs upon that which sustaineth it, according to its height.

I Have given this example, because that divers deceive themselves upon this subject, which have thought to raise Water, not considering the weight, when it comes to be raised very high. That which is then to be understood by this Proposition, is that the sucker C, being at the end of the pipe M, to sustain the Water which is within the said pipe, that the Water weighs upon it according as the height thereof shall be in the pipe. As let us suppose that the Water be in the pipe as high as D, and that it weighs 20 pounds, if we fill the said pipe to E, which is as much again, it shall weigh 40 pound, and if we double it againe, it shall weigh 80 pound: And according to the greater or lesser height of the Water within the pipe M, the sucker C shall be harder or easier to lift up, which is that which ought to be considered, when the water is to be raised very high: to the intent to proportion the thickness of the pipes to their height: so as the Water that is in them may not be too heaveie for the moving force. It is also to be Observed that in Cisterns the force of the Water ought not to be taken from the bottoms where the pipe is souldered, but from the superficies of the Water which is in them: as may be seen in the Cisterns A and B: wherein the Water that is in B hath more force, because it is higher then A, although the pipes are of equall thicknettes and lengths.



PROP. 9.

The Water naturally ascends to the levell of the place from whence it did descend.

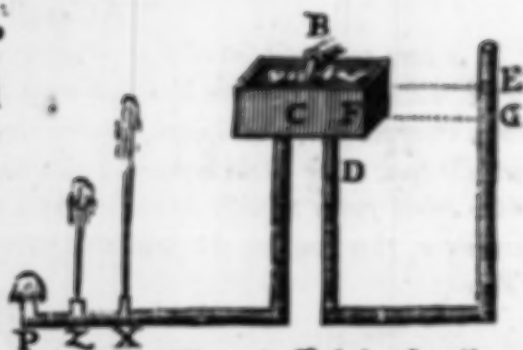
THIS proportion is very intellegible, and is as much as to say that if there be a Spring as B, the Water whereof enters into the Receiver C, and if there be a pipe as D descending right down or obliquely, the

D

Water

6 The Theorie of the Conduet of Water.

Water shall ascend therein to E, which is the leuell or height above of the vessell C: and if the said vessell be not full but to the point F, the Water shall not ascend through the pipe D, but to the point G, the leuell of the said point F, and although the pipe coming from the vessell C, be not drawn so high, if the end of the pipe through which the Water passeth be small and the pipe great, it shall ascend to its leuell, but according as the ends of the pipes through which the said Water passeth are greater, so the Water is deficient in its height. This may be seen in the figure by the small pipes X Z P.



PROP. 10.

Of the crooked Pipe, by which the Water is drawn forth.

THis pipe is in use in divers places, and hath been treated of by *Hero of Alexandria*. But it must not be here omitted, because it falleth severall times in use for our subject, and also to understand the reason thereof: this pipe then is called by divers a *Syphon*: and hath that end which is without the vessell longer then the other, And if the *Air* be drawn forth which is within the said pipe when it begins to run, it shall not cease untill it have emptied the vessell as high as the other end; And that which in effect may seem strange of the said *Syphon*, is, that the Water riseth higher then the top of the vessell by the said pipe: the reason whereof shall be given thus. Let the vessell be B, and the *Syphon* CVX. And let the top thereof be V and the end V X longer then V C, then when the *Air* which is in it, is drawn forth by the end M, the Water of the vessell B enters therein to fill the place. Now it being full the Water contained from V to X being more heaue then that from V to C, makes it run towards M. And as that Water cannot run forth of the pipe, unless there enters something therein to fill the place, and the *Air* cannot enter the water by any place of the vessell B, the Water shall ascend untill it comes to empty it self to the height of C, and then the *Air* entring therein the course of the water shall cease.



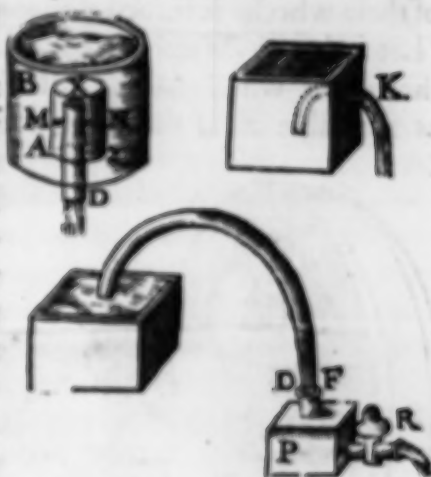
PROP.

The Theorie of the Conduct of Water. 7

PROP. II.

Of another kind of Syphon: and how the Air may be drawn forth by the means of another vessell.

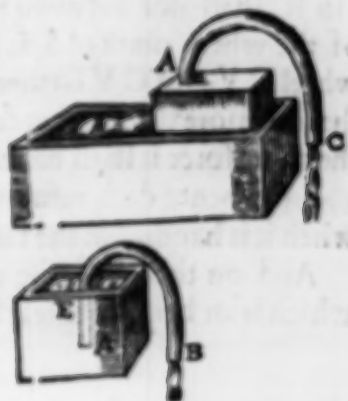
T Here may be made divers kinds of Syphons, but behold here one which seemes to be most different: which nevertheless depends upon the same reason with the former. Let the vessell be B, and let the pipe D C be souldered to the bottom passing through it: Then let one end of the pipe A X Z be put about it, so as the end X may be closed and souldered so as the water may not enter but by A Z, but A Z must not touch the bottom: therefore the pipe A X Z shall be fastened to the pipe D by two small tennons M and N, and it must be observed that the said pipe A X Z ought to be made of such a thickness that the Water contained between it and the pipe D may be equall to the water which is in D, the which being done the Water may be drawn forth by D, and performe the same effect as the former. But if either the one or the other of those Syphons contains so much Air that it cannot be drawn forth by aspiration, there shall be made a vessell as P very close and souldered on all parts, and it shall have one end F to joyn with D, the which vessell fill with Water, and joyn F and D together without taking Air, then if you turne the cock R the Water that runs forth from the vessell P shall draw the Air of the Syphon. And make it run.



PROP. II.

The Water runs equally by the means of a Syphon, if the end by which the Water of the said Syphon ascends doth only touch the Superficies of the water of the vessell.

B Ecause that in the foregoing pipes the Water runs not equally, being slower at the end then at the beginning. It shall be shown in this example how it may run equally, that is if to the end A of the pipe A C a small vessell of any matter be put, let it be what it will, so it may float upon the Water, and the end A of the pipe A C be put through the same, so as the end may touch the superficies of the Water, it is certain that the end C shall run equally, which is not so in other Syphons, the which run alwaies swifter at the beginning then at the end.



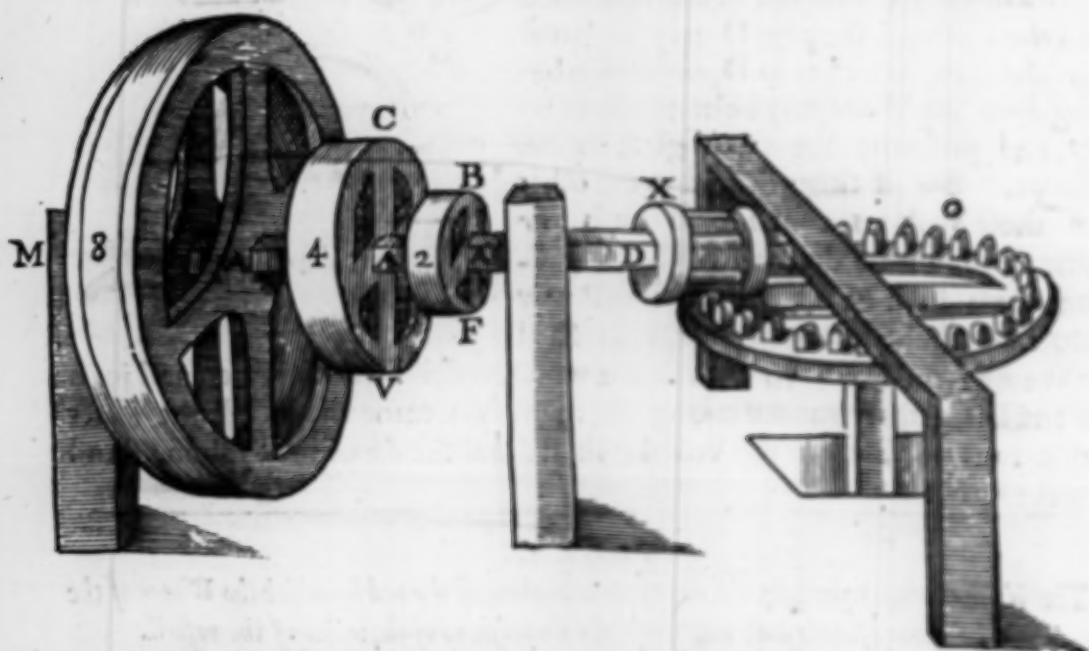
8 *The Theorie of the Conduct of Water.*

PROP. 13.

The farther that the moving force is distant from the center of motion, the more force it hath.

The force moved with the wheel XO is understood by a Tree or Axis marked with DAM.

The force moving is represented by the three wheels marked with BF, CV and 8, the which are of several magnitudes, that is to say BF of two feet in diameter, CV of 4 feet, and the largest of 8 feet. I say that if each of these wheels is turned alone and by it self, by an equall or the same force, (Let it be by Water or counterpois) that the same weight or force put to the greater wheel marked 8, shall make the tree and wheel XO move 2 times as forceable as if the same weight or force were put to the wheel CV:



(so it shall doe between CV and BF) and that because the circumference of the wheel marked 8, is further distant from the center of the tree then the wheel CV, and CV farther distant then BF, therefore it shall be concluded that the more the moving force is distant from the center of motion, so much the more force it shall have.

From hence doth result the force of the *Leaver*, the which hath more force when it is handled at the farthest distance from the burthen.

And on this likewise depends the reason of the tree of the *Screw press* which is an Engin of great force.

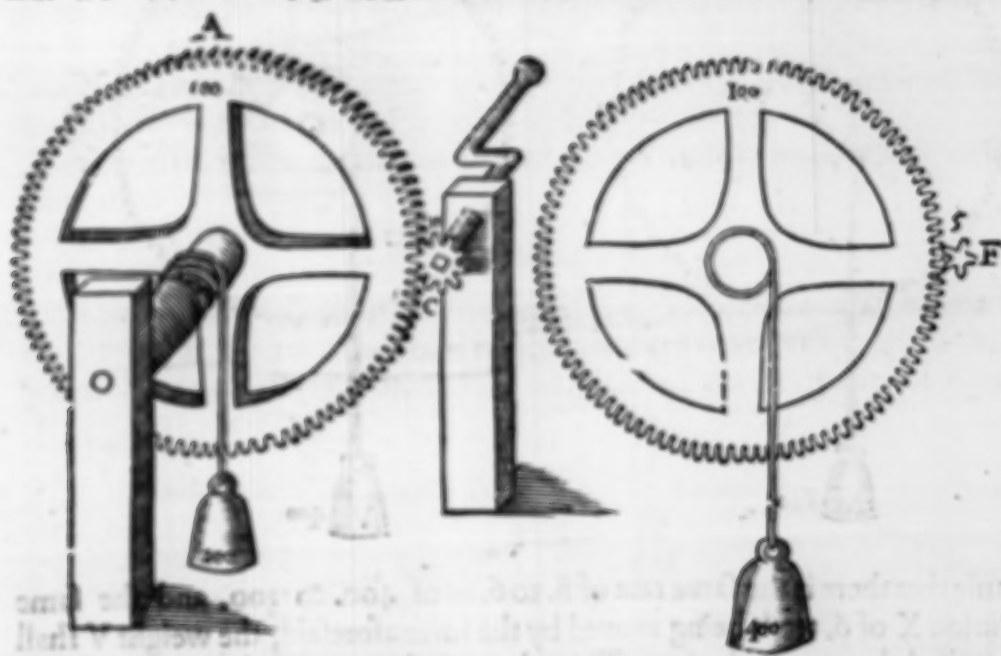
PROP. 14.

The Theoric of the Conduct of Water. 9

PROP. 14.

If a Wheel be turned by divers Pinions, to whose Axis any weight be fastened, the lesser Pinion shall be capable to move the greater weight: but it shall not turn the Wheele so fast: and there shall be such rate or proportion of the quantitie of one weight to the other, as is the difference of numbers of the Teeth of the said Pinions: and the times of raising the weights shall have also the same proportion the one to the other.

Let the toothed Wheele be A, the number of Teeth whereof let be 100. if this Wheel be led with divers Pinions, and the same force moves them, that Pinion shall give the most force to the Wheel to raise any weight whose number of teeth is the least: But the said Wheel shall turn slower, as hath been said. And herein behold the Example, If the Wheel A be turned by the Pinion C of 10. Teeth, and be capable to raise a weight of 200. and instead of the Pinion of 10. teeth, it be turned by a Pinion of 5. then it the force to raise 400. But as the weight is double in gravitie to the first, so also it shall be as long again a raising up, because the Pinion being 10. and the Wheele 100. the Pinion ought not to be turned above 10. times to make a whole turn or revolution of the Wheel: But if the Pinion be 5. it must make 20. turns before the Wheel makes one,



because the number 5. is contained 20 times in 100. And so as the Pinion C is double to the Pinion F, the weight raised by F, shall be double to the weight raised by C, And the time of the raising it shall be also double.

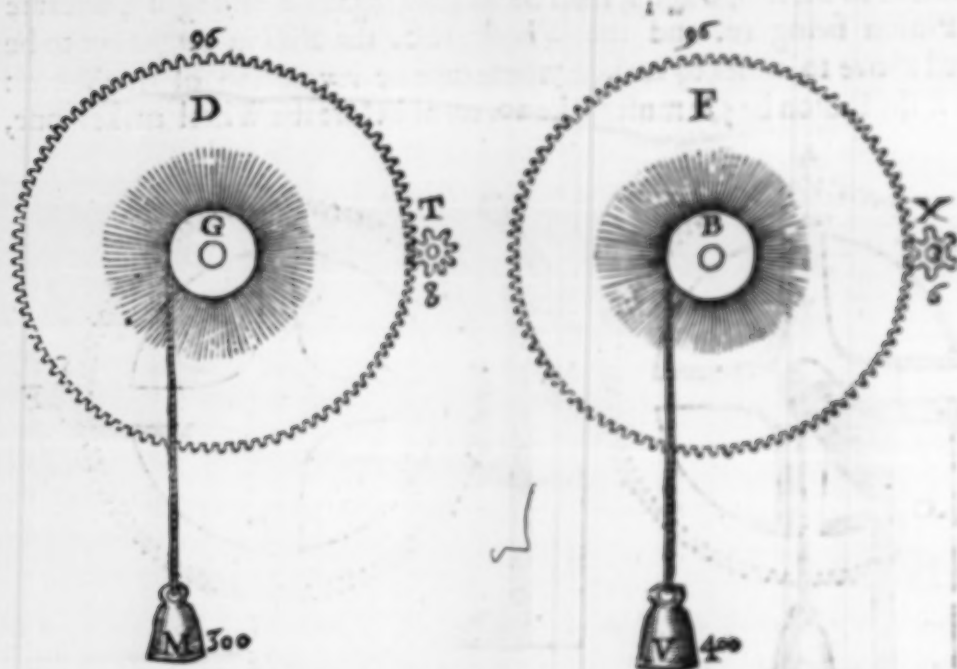
10 *The Theorie of the Conduct of Water.*

PROP. 15.

If two Wheels are equal in Form and Matter, and there be unequal Weights fastened to their Ax-trees, they cannot be moved by the same Force in the same Time,

This Proposition doth in some sort result from the former, as may be seen in the Demostratation.

Let there be two equal Wheels D and F, of 96. Teeth, and let there be fastened to the Axis G a weight of 300, and to B, one of 400; and let it be supposed that the Pinion T, of eight teeth moves the said weight by the means of the force of one Man. It is certain that if there be put to the Wheel F, a Pinion equal to T, that the same Man or the same Force which was onely made to turn T, will not suffice to turn a Pinion equal to it in the Wheel F, because of the weight V, which is heavier then M: If then you would move the Weight V by the same force; you must put to the Wheel F a Pinion which hath such proportion to T, as the weight M hath to the weight V. Now the Pinion T being of 8. the Pinion X must be of 6. be-



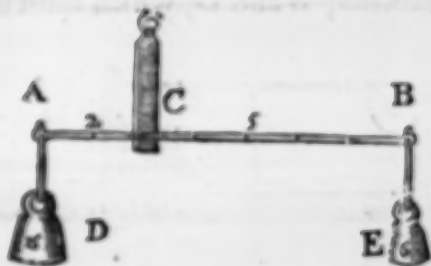
cause that there is the same rate of 8. to 6. as of 400. to 300. and the same Pinion X of 6. teeth being moved by the force aforesaid, the weight V shall be raised; but not in the same Time, because there are made but 12. Turns of T, to make one Turn of D, and there must be 16. Turns of X to make one Turn of F.

The Theoric of the Conduct of Water. II

PROP. 16.

If two unequal Weights be put to the ends of the Beam of a Ballance, and if they be hanged on a point which divides the Beam into two parts having the same rate the one to the other, in length, as the said weights have in heaviness, Those weight although unequal shall be in equal ballance, if the lighter be put to the end of the longest part of the Beam.

Let the unequal Weights be D and E, and let D be 15. pound weight and E 6; I say that they being at the end of the Beam of the ballance A B if they be hanged on a point as C, so as the part A C may have such proportion to the part C B, as the weight E to the weight D; D being at the shortest distance from the center of the Beam shall not weigh more then E, which is at the longest end: because the weights are hevie in proportion according to their distance from the point on which the Beam of the ballance is hanged.



Now if the Beam of the ballance be divided into 7 parts there shall be 5. parts on the one side of the Center, and 2. on the other, which are in the same proportion as the Weights 15. and 6; because 6. is the two fifts of 15, as 2. is of 5. And if the difference of the Weights D and E, were greater or lesser, they shall alwaies be in equal Ballance, if the Beam be hanged from a point which divides it as is before said: You may see other Examples in the Figures following P, which differ from this.

A Corollarie.

From hence it follows, that two equal Weights are not alike hevie if they be put at the end of a Beam which is hanged from unequal parts: And it must be observed that although the two sides of the Beam are in equal



ballance, if they are of unequal length, equal weights shall weigh unequal.

As for example, If the Beam A B be hanged in C, so as C B may be longer then A C by a fourth part, and yet A C and C B be in equal ballance, because the part A C is thicker then the part C B, yet if the equal weights D and F, be put to the ends of the Beam A B, the weight F shall weigh a fourth part more, which is the difference of B C and A C.

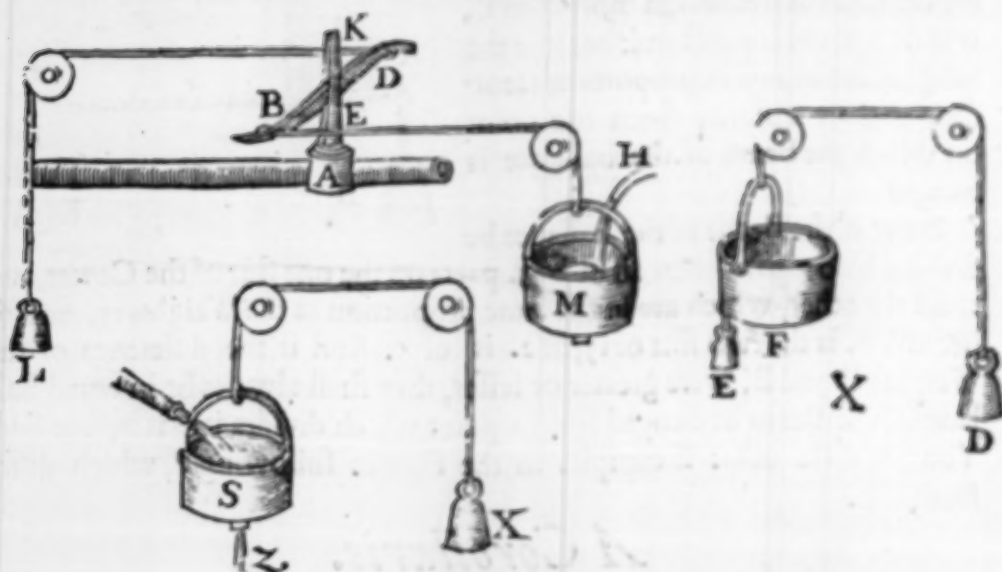
12 The Theorie of the Conduct of Water.

PROP. 17.

The manner to shut and open the Cocks of the Pneumatique Engin, by the means of Water.

IN the Construction of the Pneumatique Engin which causeth Water to mount higher then the Spring, There is required a Vessell which ascends and descends by means of the Water to turn the Cocks; therefore I have put here certain examples, among which you may chuse the most convenient both for that Engin, and for the other Engins.

As in the first place, Let there be the Cock A, which is to be turned by means of a Vessel: First there must be put the key K E, which hath two branches, B and D, which must be long or short according as the said



Cock is hard or easie to turn; as may be gathered from the 13. Proposition; and there shall be two smal chains or chords at the ends of the two branches; at the one of them shall be the weight L, at the other the Vessel M; but it is necessary that the weight L, be heavier then the Vessel M when it is emptie, but when the said Vessel M is full, it ought to be heavier then the weight L, to the intent to make the Cock may turn both waies;

Now behold the effect of the Vessel, in which there is a Syphon, which shall be something lower then the height of the Vessel; and the said Syphon shall be larger then the Pipe which gives Water to the Vessel; when M is emptie the weight L shall turn the Cock towards it, but when the Pipe H, hath filled M, then the said M weighing more then the weight L, shall draw back the Cock towards it self, and then the Syphon beginning to run shall make M lighter then the weight L, and so the Cock shall be turned back again.

There may be also made another Vessel as F, which may be so hanged upon the handle as it may be moveable upon two Pins, and may over-turn and emptie the water when it is full. And to perform this, the Pins must not be diametrically opposite, but more towards one side then towards the other; Now because the said Vessel being emptie should return of it self, the

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the counter-poise E must be put to the lighter side, to ballance it equally; this being done, if there be a weight (as hath been said in the foregoing Proposition) which shall be heavier then F, that Vessel F shall be at the highest when it is empty, but when it is half full being heavier then D, the said Vessel shall descend towards F, and being full it shall empty it self towards X: and being empty it shall be again lighter then the Weight, and return to its first place; where it shall be till it be filled again to descend.

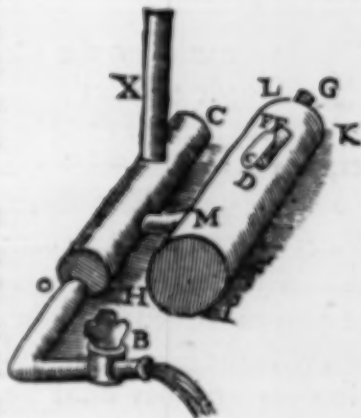
The reason of the emptying may be gathered from the *Corollarie* of the 16. Proposition.

There may be also made another manner of Vessel for the same use: as you may see in the Figure S Z X.

PROP. 18.

Of the Value or Susprial.

IT will be also necessarie for the understanding of the following Engin to demonstrate the manner of the value of Copper which openeth it self by intervals; to the intent that if the *Air* may enter into the Vessels from beneath, and shut it self when the said Vessels are full; to the end that the Water pass not out by it. The which value shall be figured thus, Let H I K L be a smal box of Lead, about one inch and a half in diameter, and 3 inches long very wel Soldered, within the said box is the value G D C E made after this manner: G D is a smal Pipe of Copper, about $\frac{1}{4}$ of an inch; and towards the end D there are two smal props which hang the tongue or value of Copper C, which falls upon the hole D, to shut it when there is need, there is also to the box H I K L a smal Pipe X M, the lower part of which is soldered to the Pipe O C.

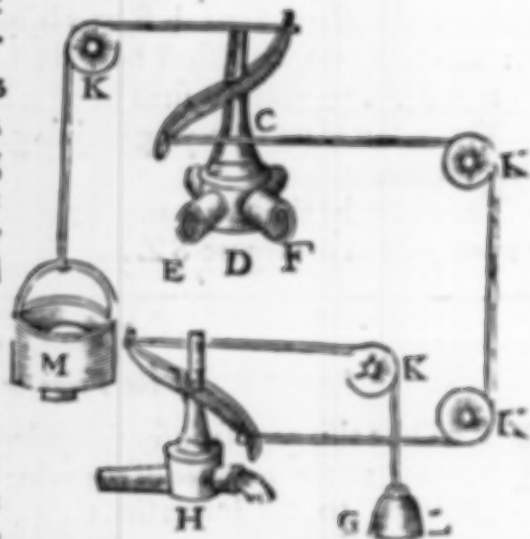


Then to see the effect of the said value; Let us suppose that there is two Pipes to the Pipe C O, the one to empty it, and the other to fill it: and let the Pipe X be stopped, which is that which fills the said Vessel, and let B be opened; then the Water that comes from the Vessel draws in the *Air* by the smal Pipe D G, and lifts up the Copper tongue C and B: Being stoppt it shuts it self and when the Water hath filled the Vessels C O, and H I L, the said Water pressing the value against the end C, there shall no Water come forth.

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PROP. 19.
Of the Cock with four Vents.

THis Figure following is set down to shew more distinctly the manner of the Cock D, whose barrel is pierced in 4 places; to the end that the key C turning either one way or the other, in the required time, the water may sometimes run out by E, and sometimes by F; and that For E may run when the hole of the key C shall agree with the one or the other of them: It shall also empty by means of the Vessel M, as the Cock H shuts, when one of the Pipes is opened, and then when the said Pipe shuts to make the other Run, then the Cock shall open again by means of the counter-pois G L, and the Pullies K, As you see it in the figure.

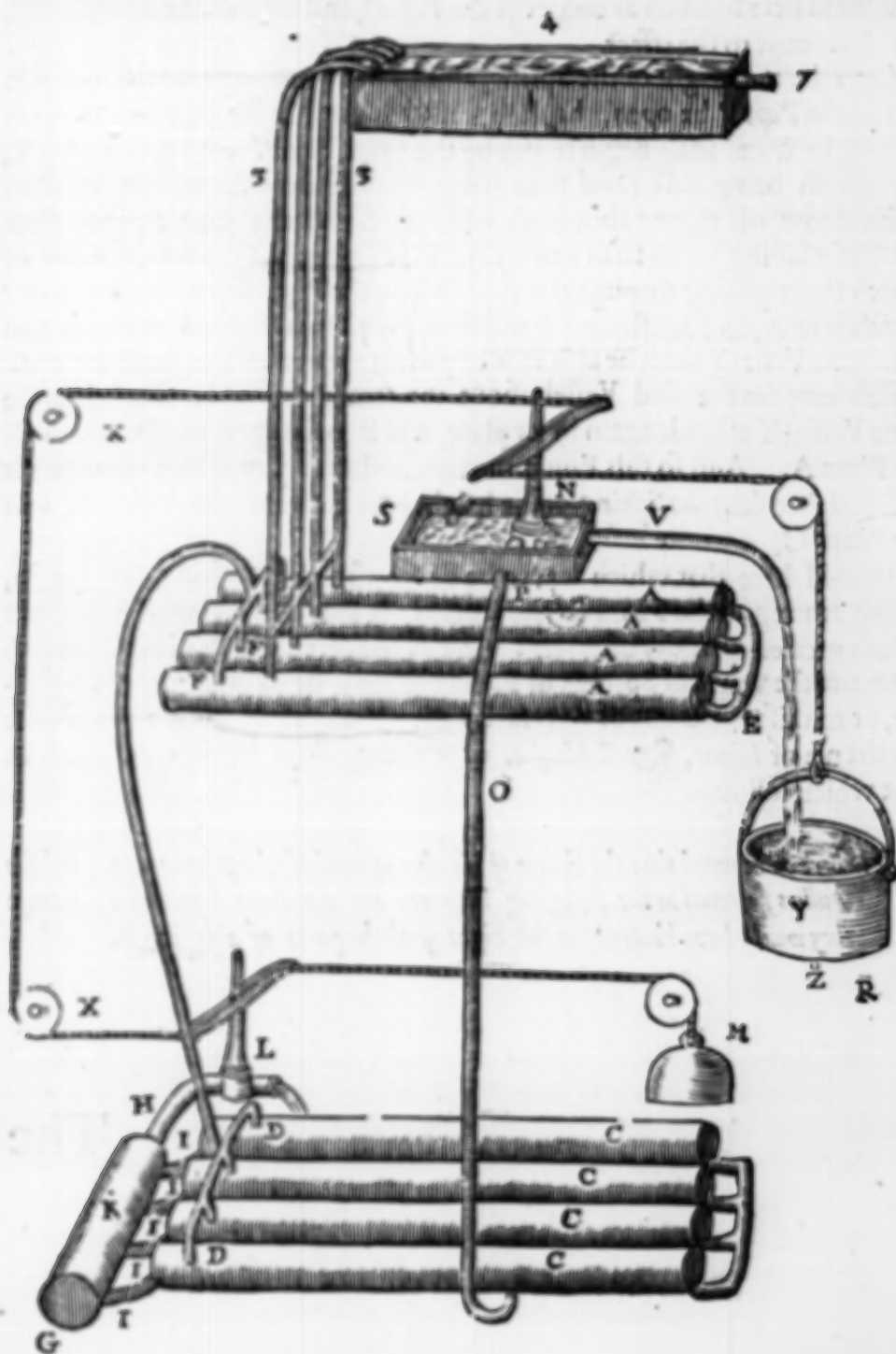


A Description of the Engin by which part of the Water is raised higher then the Spring.

TO come to the Coustruction of this Engin. First let there be made 4. Pipes of Copper, or of thick Lead sufficient to bear the strength of the *Water* and *Air*, and let them be 6. inches in Diameter, and 6. or 7. foot long, marked in the Figure with the letter A, and let the little Pipes E be Soldered to the ends of them at the bottom, so as the *Water* may be communicated from one to the other: furthermore let there be Soldered four smal Pipes F, above the Pipes A, to the intent that the *Air* be communicated from the one to the other: also let four little Pipes marked with the figure 3 be Soldered, which are those by which the *Water* ascends; and they must be Soldered a travers above the great Pipes, and the end entring within almost to the bottom. Moreover there must be four other great Pipes made like to the first, the which shall be put asmuch lower as you would raise the *Water* higher then the Spring, and let the smal Pipes D be Soldered in them, to the end that the *Air* may enter there when the *Water* enters by the Pipes C, and therefore let them be Soldered above; and let there be four Pipes at I communicating all the *Water* to the Pipe G H, and let the Cock L be Soldered to the bottom of that Pipe and above at the top let the value K be Soldered, made as is before described in the 18th Proposition: and let the Pipes D and F be made common by one Pipe: moreover let the smal Vessel S be made, which may have the sides about the height of one foot; and upon the bottom of it by the base of the *Emboiteure* let there be Soldered the Cock N, to which Cock let there be the

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the Pipes O and P, the which Pipe P shall go almost to the bottom of one of the Pipes marked with A, and O shall be conducted almost to the bottom of the Pipes C: also at the top of the Vessel S, let there be the smal Pipe V, to give Water to the Vessel Y, when it is required: which Vessel Y shall be of Copper, having a smal hole at the bottom. Concerning the motion whereof, it hath been declared in the foregoing Examples, There must be also a Counterpoise M, to the intent that when the Vessel Y shall be empty it may draw back by its weight as well the Vessel as the Cocks, in their place



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by means of the smal chains and Pullies X : There shall be also at the end of the Pipes marked 3, a Vessel marked 4, to receive the Water which shall be there discharged by Intervalls from the said Pipes, and to render it by the Pipe 7, which runs continually being of equal thickness to two of the smal Pipes marked 3, the which shall raise the Water higher then the Spring ; as high as you will, if there be place to put the Pipes C low enough : because that the further the Pipes A and C are the one from the other, the higher the Water will rise, to the Vessel 4.

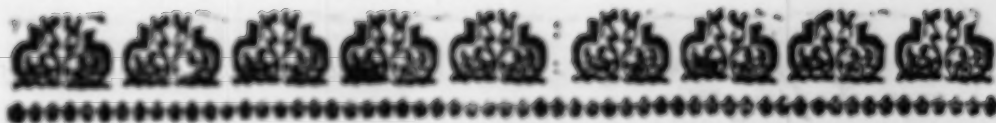
Behold here somuch as concerns the *Fabrick* and disposition of the Pipes. We come now to the effect.

Let T be the height of the Spring, and let the Water run into the Vessel S, and let the Pipe P be open, then the Vessels A shall be filled, and when they are full the water shall begin to run by the smal Pipe V into the Vessel Y, the which being full (and then being heavier then the weight M) shall descend towards R, and shut both the Cock L and the Pipe P, and then the Water falling into S shall run by the Pipe O into the Pipes C, the Air of which Pipes passing through the Pipe D into the Pipes F presseth the water which is in A, and constraines it to ascend by 3. Now when A is empty and C full, the Vessel Y shall be also made light by means of the smal Pipe Z, which empties the said Vessel about the same time as C is filled: then the same Vessel Y ascends again in its place, and P opens as it was before to fill the Pipes A. And so this Engin moves continually, by which the water is raised higher then the Spring, of the height as is between the Pipes A, and the Pipes C.

Behold here that which was to be demonstrated touching this Engin, which among all the *Phneumatique* Engins, is that which with less force raiseth greatest quantity of Water : And as concerning other inventions to Conduēt the Water of Springs or Falling waters, or to make them Navigable, or to raise Water out of Rivers by divers waies, in great abundance for the use of Towns, Royall Houses, or Pallaces, shall be demonstrated in that which follows.

It is here to be noted that the Frame of Timber upon which the Pipes are put, and the pullies fastened in the foregoing Figures, are not there described: Because they would have hindred the full Sight of all the parts of this Engin.

The



The Explanation of the *PLATES* and *FIGURES* Following.

The first Plate, Figure I. To raise Water by the currant of a River, and the force of a Pump.



THIS Engin commonly called a Pump, is called by *Vitruvius* and *Hero*, the *Stefibique Engin*, retaining the name of the Inventor thereof, which was *Stefibius* of *Alexandria*. I will shew three waies to raise Water by this Engin. The first shall be by the currant of a River (as the Figure Shews) where there is a water Wheel, and at each end of the Axeltree of the said Wheel is a handle of strong Brals, and forged to sustain the force and weight of the said Wheel: and if the said Wheel be ten feet broad, and twelve feet in Diameter, the said handle shall be at least four inches square, and shalbe rounded in the middle at the places marked with A, and there shalbe also two peeces of wood called Levers marked with the letters B and C, fitted to the arm of the said handles, the one of which riseth, and the other goeth down when the Wheel turns: and the said Levers shalbe also fitted to two arms or branches marked with D and E, the which raiseth the Buckets and Suckers of the Pumps Alternately, and so the Water shall be raised to the Vessel F; And from thence you may conduct it whither you please. As concerning the height which it ought to rise, I am of opinion that it must not be constrained to rise more then thirty feet in height with one Pump; as shall be taught in the following Probleme: the great Pipe G, is the place where the Sucker lyes, which sustains the Water when the Buckets or Suckers of the Pumps are not lifted up. The Figure with the ordinary practice which is had of Pumps, will make you easily understand this Engin. And if the currant of the River be strong, and it is required to have store of Water, you may make the Diameter within the Barrells ten or twelve inches, and the height eight or nine Foot: And to make it well, the Buckets ought to rise and fall four foot, and when they are at their greatest height that they may have four foot of Water above them, to the intent that the Air may not escape, for if the Water be not high enough between the top of the Barrel and the Bucket, the Air will pass thorough the Water by bubbles, and make the Engin useles: and especially when the Water is forced to rise above fifteen or twenty foot. Therefore you must take heed that that accident do not happen. The proportion also of the Pipes MNO shall be about four inches in Diameter, if the aBrrells be twelve: if the said Barrells be less, the said Pipes shall be less in proportion.

The Explanation of the Second Figure. Plate II. Another Way to raise Water by means of a falling Water.

THis other manner of raising of Water, is done by a falling Water, raised so as it may fall upon the Wheel A, to turn it, and in turning it to raise the Water of the Pump B, to 24. or 30. feet high, and the other side C takes the said Water in the first elevation in the Trough D, and may raise it from thence 24. or 30. feet high. The foregoing Figure will give the manner and way of the raising of the Water in the first height: and the second height is done after the same manner, as may easily be comprehended by the Figure: the which Figure is not made high enough according to the proportion of the measures, because the Paper would not permit: but you may easily imagine the said height, as it ought to be.

Explanation of Plate III. To raise the Water of a Spring, or River by the force of Horses.

BUt if there is not a River strong enough, nor a falling current, the Water may be raised by the means and force of one Horse, or more, according to the quantity and the height which is desired. This present designe is made to raise the Water 60. foot high, and four Horses will raise about 60. in an hours time, which is about 30000. pound weight. Therefore first let there be a straight Axeltree of wood, a foot square, and 60. foot high, marked with A, the which turns between two Pins, and above near the end, there is a Wheel of 24 Teeth, marked with B, the which turns a Lanthorn or Pinion of 12. Staves, marked with C, and a Wheel of eighteen Teeth, marked D. But there are but nine Teeth in the half of the Circumference, the other half is void, and there are also two other Wheels, marked with E and F, of equal bigness, and also nine Teeth on each Wheel; and let the toothed part of all the three Wheels be put above: then there must be a Pulley put above marked with G, over which a Cord must pass, the which must be fastned by the two ends to the Axeltrees of the Wheels C and F, so as turning about one of the Wheels it may unturn the other: as you may see, and better consider in the Figure of the *Orthographie* following. Then you must put the said Wheels E and F, against D, so as D turning alwaies the same way may make E turn half a turn, and then when it shall be in the last Tooth, the first of the Wheel F shall represent it self against the Wheel D, because the Wheel E shall make it turn back again, by means of the common Cord and Pulley G: and after the said Wheel D hath caught the first Tooth of F, it shall continue to the ninth; and afterwards the first of the Wheel E shall represent it self again. And so the two Wheels E and F shall turn forward and backward half a turn alternately: and to the Axeltree H and L there shall be fastned two strong Cords, which shall draw up the two Buckets which go into the Barrels M and N, and have about three feet play, rising and falling, and they shall be made of Brasis, well fitted within the Barrels, and that they may descend of themselves without being constrained,

constrained: And so there is no Leather put about the Buckets, as is ordinarily done in common Pumps. And it is to be noted that the swifter the Buckets come up, so much the more Water they raise, which may be observed in all sorts of Pumps.

It is also to be noted that the two Transverse peeces O P ought to be but one peece, to the which the other Transvers peece Q ought to be joyned, in the which the four ends of the Axeltrees of the Wheels B C E F do turn.

The Explanation of Plate IIII. This Plate gives a larger demonstration of the former, by means of the Orthographie.

FOR the better understanding of the foregoing Figure, I have represented here the plain of the *Orthographie*, to the end that by it you may understand the motion and meetings of the three Wheels E D F. Let then each of those Wheels have nine Teeth in the half Circumference, and let that part of the Wheels that hath the Teeth in them be turned upwards, so as the first Toothe of the one meet with the Teeth of the Wheel D, when the last of the other hath passed beyond it; and there must be a Cord marked R S to go in a Pulley marked T, the which shall be firmly fastned to the two Axeltrees, as may be seen in the Figure. So as if the Teeth of the Wheel E be entred, it shall make the Wheel F to turn half a turn by the Cord which is fastned to the Axeltree of the said Wheel, and shall present the first Toothe V when the last of the Wheel E marked with X shall be passed: and so the Wheel F making its half turn, shall make E to return as it was before; so as by means of these half turns (turning and returning) the Buckets of the Pumps shall be raised and depressed, as if it were with a turning handle: And the difference which is between the said handle and this present Invention, is, that the said handle doth not raise the Bucket Perpendicularly, as this present Invention doth, the which is much better. Likewise to raise the Water very high, and in such abundance, it is necessary that the said handles be very strong, as hath been said before. And if you will not use the said handles to the foregoing Engins to raise the Water by the means of Water Wheels, you may use this present Invention.

As concerning the Barrels, if you would spare the quantity of Brass or Lead which they ought to have in making of them 30 or 40 foot long, you may make them onely of 4 foot long, of the Diameter of the Bucket, and over them viz. at Z Y fit smaller Pipes into them: as you may see in the Figure.

The Explanation of Plate V. To make a Dial with the course of a natural Fountain, the which shall move very true, without being subject to be wound up Dayly.

LET the course of the Fountain be from the Pipe marked with A, the which shall be hollow within about the Diameter of a writing Quill, the Water whereof shall fall into the Vessel B, to which there shall be two Pipes, that is one marked with C, Soldered to the bottom of

the said Vessel, which hath a smal Cock marked D, then there is a smal emptying Vessel marked with E, and the said Vessel shall be fastned to a smal Lever marked with F G, made as the Figure demonstrates, with a hinge to bend only one way: and the end of the said Lever shall be entred in one of the Teeth of a great Wheel, marked with H I, so as the Vessel E descending the end of the Lever G shall raise the Tooth in which it is entred, somewhat more then one Tooth, to the intent that the greater Leaver L may fall into the next Tooth, and stop the Wheel H I: there shall be also a counter-pois marked O, fastned to the Lever F G, to draw down the end G, when the Vessel E is empty, and so the Water falling in the said Vessel shall make it heavier then the counter-pois O, and then it shall descend and raise the end G, and move the said Wheel H one Tooth: and the Water falling alwaies shall fill the said Vessel and make it to overturn, and then the counter-pois O being heavier then the empty Vessel shall again draw down the end G, and the other above marked with L shall stay the wheel that it shall not return: The said Wheel must have 60 Teeth, and so the Water which falls in the Vessel E being so justned by the Cock D, that every minute of an hour the said Vessel may overturn, and by that means the Wheel H I shall make one Turn in an hour: and then you may make a Pignon to the Arbor of the said Wheel having six Teeth, the which may move a Wheel of 72 Teeth, and by that means the hand above M shall shew the course of the 12 hours, and that beneath shall shew the course of one hour: and when the said Dial shall be well justned, it shall continue a long time without alteration. You must also note that it is necessary that the water of the Vessel B be as high as the Pipe P, to the intent that the said Water fall alwaies equally in the emptying Vessel, and that it may so do, it is necessary that there fall somewhat more Water into the said Vessel B, then there runs forth by the Pipe C: and the overplus shall run out by the Pipe P.

The Explanation of Plate VI. To counterfeit the Voice of smal Birds by means of Water and Air.

Let there be two Vessels marked with A and B, that marked with A shall be filled with water, and that marked with B very close and Soldered on every side, then the Pipe C D, must be Soldered one end to the bottom of the Vessel A, and the other passing to the upper part of B, and that the end D may be so far distant from the bottom of B as is necessary to let the Water pass, there must be a Cock marked with P, to the said Pipe, to open and shut it when it shall be required: There must be also made the Pipe G H, by which the Air may pass through the said Vessel A, or else it shall be conducted to the place where you would make the Birds to Sing, to the end of which shall be fitted a smal Whistle like to those which the *Organ makers* do make, to represent the Song of a *Nightingale*, and the said Whistle shall be put into the Water, and so when you open the Cock F, the Water shall descend to the lower Vessel, and the Air which is in the said Vessel shall issue forth by the Pipe G H, the which shall make the Whistle to sound which is

at the end of the said Pipe, and then you may put to it an Artificial Tree, upon which you may put some Birds of Wood or Mettal, painted like as the natural.

As concerning the Figure of the Globe D B, it may serve for pleasure to cast the Water very high by the Pipe A, after that you have forced it in with violence with the Seringe C.

And for the manner of the Whistle put into the Water, you may see it Figured in the following Figure at the place marked with K.

The Explanation of Plate VII. To add a Swan or other figure to the singing of the Birds spoken of before, which shall Drink or Sip up as much Water as you shall present to her Beack.

THis is onely the difference between this and the foregoing Figure, that the Vessel above marked with A is close and Soldered on every side: it shall have a smal receptacle or Funnel N to fill it, the which being full and N stopped, when you open the Cock F the Water entring into the lower Vessel shall make the Air pass forth, and so make the Birds Sing, and the Water passing out of the upper Vessel A shall sip up by the Beack of the Swan all the Water or liquor which you shall put under her Beack.

It hath been said before that K is the Figure of the Whistle put into the Water to immitate the Singing of Birds.

The Explanation of Plate VIII. To make an Engin which shall move of it self,

THere have been divers Men which have Travelled to find out a motion which they have called (without knowledge) Perpetual, or without end, a thing very ill considered and ill understood, because all that which hath a beginning is subject to have an end; and the word Perpetual or without end ought to be applyed to God alone, who as he had no begining, cannot also have an end, so as it is folly and deceit in Men to make themselves beleeve that they can make perpetual Works; seeing that themselves are mortal, and subject to an end: so also are all their works: Therefore I will leave those words of Perpetual or without end, and will shew the *Fabrick* of an Engin which shall move of it self, seeing it is Intertained of the four Elements, of which it is composed, and the reason of its motion shall be Heat or want of Heat, which shall serve as a Counter-pois to that Engin: as may be seen here by the Construction. Let there be a Vessel of Lead or Copper, about a foot and a half square, very close and Soldered on every side, which shall have a Pipe in the middle, marked with D E, the end E shall be neer the bottom of the Vessel, leaving onely room for the Water to pass, the other end D shall be well Soldered against the top of the Vessel, and it shall have also a vent marked with F: afterwards you must raise up the two sides of the Engin N M, so as the Axtree O with the Pully G may turn easily, and may shew the motion of the said Engin with-

out the side M: the motion of which Engin with the Index is oppositē to the said Axtree: there must be also the border P Q Soldered upon the Vessel, the which shall serve when you will to put Water into the Vessel; and also when the water ascends by the Pipe E D that it might not scatter abroad: all this being well and justly made, powr Water into the said Vessel by D E, till it be about the third part full; and while you put the water in open the vent F, But when the Water is in, stopp it very well. Then you must have a little bal of Copper very light, marked with the letter L, the which may float upon the Water, and shall be fastned by a smal thred, so as the said bal may Ascend and Descend by the Pipe D E, when the water riseth and falls: also the said thred to which the bal is fastned must pass over the Pully G, to the end of which thred is fastned a smal Counter-pois R, as the whole may be well seen in the Figure. Afterwards you may put the said Engin in a Chamber, where the Sun shines in at Noon: Then when it is made a little hot the bal is raised up, and the Counter-pois deprest, which will turn the Index, and will shew the height that the bal is mounted, and as it is colder the bal Descends, and so as the Times change so the bal riseth and falls. You must note that if the Vessel be one foot and a half high, and being filled a third part with Water, there shall remain one foot for the bal to rise and fall: and making the Pully four inches in Diameter, then it shall turn one Turn if the bal be raised up to the end D, so that dividing the Dyal into twelve equal parts, each part shall shew an inch that the bal hath risen or fallen.

As concerning the use of this Engin, it will serve to shew the temper of the Air, and whether the dayes are Hott, or Cold, or Temperate.

The Explanation of Plate IX.

IN this Plate there are two Figures marked with 1 and 2, the first marked with 1, is a Clock of an other manner, which may be made in places where there is found no running Spring. First there is made a Vessel of Copper or Lead, as the Figure A, the which shall hold about a Hogshhead of Water: this Vessel shall be square and somewhat higher then it is broad, in which there shall be a little Vessel of Copper, marked with F, which shall be also square, very close, and Soldered on every side; the which is to float upon the Water of the said Vessel A: afterwards there must be a Syphon, or Crooked Pipe, made as the Figure B C D doth demonstrate, the which must pass through a Pipe of Copper, which shall be in the middle of the little Vessel: and the said Pipe must pass from one part of the said Vessel to the other, and the Syphon must enter into it with some force; and the end of the said Syphon must enter into the Water of the Vessel A: and above at the point C there is fastned a Cord passing over the Pully L, and at the other end the Counter-pois E shall be fastned, and there shall be fastned an Index to the end of the Axtree I, the which shall shew the Hours on the Dyal O P: and after the Vessel A is filled the Vessel F is put into it, as hath been said, and also the Syphon and Counter-pois: then you shall draw the Water of

of the said Syphon at the end D, with the mouth: and because the said end is lower then the level of the Water of the Vessel A, the said Water shall have its course and shall fall in an other Vessel marked with H, and according to the measure that the Water of the said Vessel Descends, the smal Vessel F Descends with the Syphon, which causeth the Pulley to turn, and consequently the Hand of the Dial. To justen the course of the Hours, you must lengthen or shorten the Syphon in the Copper Pipe of the smal Vessel: for putting the said Syphon more into the Water it shall run Swifter, and on the contrary drawing it back it shall make it run slower: it must also be noted, to make it go very true, it is necessary to fit a smal Pipe to the end D, the end of which, where the smal hole is by which the water runs shall be of fine Gold, to the intent that the said hole may not wear, which it will do if it be either of Lead or Copper: and when the Vessel A shall be near empty, you shall raise it again with a smal Pump marked with G.

In the second Figure of this Plate marked by the figure 2. There is declared the manner of a very Subtile Engin, to raise a standing Water, by means of the Sun.

THis Engin hath a great effect in Hot Places, as in Spain, and Italie, because the Sun shines in those places almost alwaies with great Heat, especially in the Summer. The construction whereof is thus. You must have four Vessels of Copper well Soldered round about, each of which shall be about a foot square, and eight or nine inches high; the said Vessels are marked with A B C and D: and there must be also a Pipe marked with E, put upon the said Vessels, to which Pipe there shall be Soldered four branches, each branch being marked with the letter F, the said branches shall be Soldered to the top of the Vessels passing almost to the bottom of each Vessel: Then there must be Soldered a Sucker marked with G to the middle of the Pipe, made and placed so that when the Water Springs out of the Vessels it may open, and being gone forth it may shut again: You must also have another Pipe at the bottom of the said Vessels marked with P, to which there is also four branches, the which shall be all Soldered against the bottoms of the said Vessels, and also a Sucker marked H, to the end of which there is a Pipe which descends to the bottom of the Water, the which shall be in a Cestern or Vessel marked with I: there shall be also to one of the Vessels a hole or vent, marked with M. So placing the Engin in a place where the Sun may shine upon it, pour Water into the Vessels by the hole or vent M, the which Water shall be communicated to all the Vessels by means of the Pipe P: and the said Vessels must have about a third part of their content in Water, and the Air which was in the place of the said Vessels shall pass out by the passages 3, 4, 5, 6, afterwards you must stop all those passages very close, so as the Air may not come out of the said Vessels, and then the Sun shining upon the said Engin shall make an expression, because of the heat (as hath been shewn in the foregoing Probleme) which causeth the Water to rise from all the Vessels to the Pipe E, and pass forth by the Sucker G, and the Pipe N, and then

then fall into the Basin O, and from thence into the Cestern I: and when there shall be a great quantity of water run forth by the violence of the heat of the Sun, then the sucker G shall return, and after the heat of the day is palled, and the Night shall come, the Vessels (to shun vacuity) shall draw the Water of the Cestern by the Pipe and Sucker H P, and shall fill the Vessels as they were before: so as the motion shall continue so long as there is Water in the Cestern, and that the Sun shines upon the Vessels: And you must observe that the two Suckers G and H must be made very light, and likewise very just, so as the Water may not descend by them when it is raised.

The Explanation of Plate X. An Engin by which the force of the foregoing Fountain is increased.

IF you desire to raise the Water five or six foot high, the foregoing Engin cannot raise it, if the Sun do not shine upon it with great violence: and to increase the force of the Sun, it is necessary that the Vessels of Copper be made in manner as this present Figure doth declare: and upon the side A B there are put Burning Glasses, the which shall be well fitted to the Copper, so as no Air may come forth, the said Glasses are marked (the two great ones of every Vessel) by the letters C D, (and the smal ones) E F G H, and the side of the Vessel L must be put towards the South, to the end that the Sun shining upon the said Burning Glasses may assemble the raies of the Sun within the said Vessels, the which will cause a great heat to the Water, and by that means make it spring forth in great abundance, and also higher if it be required: and as to the other sides of the Vessels where the Glasses are, they shall be put towards the West, for the Sun shines very hot After-noon: and you must observe that if the great heat makes all the Water to run out which is within the said Vessels, that is to say the third part of their contents, then you may put in more then the third, viz. a half of the content by the vent, as hath been said before. I have also made this present Figure greater then that which went before: and as concerning the upper sucker, it may be in the Vessel which sustains the Basin of the Fountain: And the Burning Glasses may be as large as they are drawn in the Figure A B, and they must be thick in the middle, as the said Figures do declare.

The manner to make a Cement, to Cement the Glasses to the Vessels, so as the Air may not come forth:

TO make a Cement to indure the heat of the Sun, and to bind well to the Glas, take five or six peeces of quick Lime, the which being covered with Brick-dust, powr a little Water upon the said Brick-dust, the which shall flake the Lime, and reduce it into powder: and you must be carefull that you wett not the Lime too much: being so brought into powder, then temper it with old Cheese, mixing also about one third part of the said

said Brick-dust: then Cement well the joynings of the said Glasses with the Vessels of Copper. There is also another Sort of Cement to be made, the which is also very good for this effect: that is to say, of Glass ground with Lin-seed Oyl, and mixt also with a little Slaked Lime: This last is also very good against the Water, and will not be moistned in any manner as the first, which serves onely for things that are out of the Water.

The Explanation of Plate XI. An Engin to Saw Wood very readily by the force of a Water Wheel.

THis Engin is very common among the Mountains of the Country of *Switzer Land*, with which they Saw great quantity of Firr Boards: the said Engin is necessary to be in a great City, or in a Forest, where there is great store of Wood to Saw, either in Boards or other form: This here is not altogether like those used by the *Switzers*, for they make the peeces of Timber to come to the Saws by means of certain Toothed Wheels with a rochet, but because of the oft reparations of the said Toothed Wheels, I think alwaies to avoid their use as much as I can. So I have put the two Counter-pois each about two or three hundred pound weight, the one whereof is marked with A, and the other with B: the Cords on which the Counter-pois hang are fastned to two moveable peeces of wood which slide upon two other fixed peeces of wood, by means of certain smal Pullies that may be within a hidge, and so the said Counter pois alwaies drawing the said moveable peeces of wood: and the peece which is to be Sawed being fastned between the said movable peeces, which shall come alwaies forward and the Saws rising and falling shall Saw the said peece with great speed: you may put two three or four Saws at the least up, on the same fram, so far asunder as the thickness of the Boards which are to be Sawed shall require. And when the peece of Timber is Sawed, then one or two Men with a Lever shall turn a Rowler to which a strong Cord is made fast, which shall draw back the said peece, and draw up the Counter-pois, and then you may put the peece a little toward one side, so as the Saws may take the said peece again.

The Exp'ation of Plate XII. An Engin of great service to Bore Elms or other Trees to make Pipes to convey Water, and for other uses.

LEt there be a water wheel to the Axtree, whereof let there be fastned a wheel of thirty six Teeth or more, according to the swiftness of the Water Wheel, for if it turn slow there must be the more Teeth, and there must be a Pinion of six, which is turned by the aforesaid Toothed Wheel, as may be seen in the Figure: and to the Axtree of the said Pinion there shall be joyned a long Auger, marked with the letter A, which shall be put through a hole marked with B, to be opened and shut as occasion shall require, as in a Turners Lathe: then the Tree to be bored is to be placed fast upon a fram, marked with C D, so as the said fram may slide easily by

the means of certain little Wheels which are in the hollow thereof, and turn upon strong pins, so as one Man may put forward or draw back the said Tree when it shall be fastned upon the said fram, and so the Auger turning, the Man shall put the end of the said Tree against it, and when it hath entered it two or three inches, he must draw back the said Tree, to draw out the chipps of the Auger, otherwise it will be in danger of breaking: and so you must continue alwaies to draw back the said Tree at the piercing of every three or four inches, to take away the Chips, till the hole be quite through: And afterwards if you would have the hole wider, you must take such an Auger as the Figure E represents, which shall widen the hole which was before made.

The Explanation of Plate XIII. A rare and necessary Engin, by which you may give great reliefe to Houses that are on Fire.

THis Engin is much practised in *Germany*, and it hath been seen what great and ready help it may bring: for although the fire be 40 foot high, the said Engin shall there cast its Water by help of four or five Men, lifting up and putting down a long handle in form of a Lever, where the handle of the Pump is fastned: the said Pump is easily understood. There are two Suckers within it, one below to open when the handle is lifted up, and to shut when it is put down, and an other to open to let out the Water: and at the end of the said Engin there is a Man which holds the Copper Pipe A, turning it to and again to the Place where the fire shall be.

The Explanation of Plate XIII. To represent divers Birds which shall Sing diversly when an Owl turns towards them: and when the said Owl turns back again, they shall cease their Singing.

THis motion hath formerly been represented by *Hero of Alexandria*, but not with so great variety of Birds, as I will here represent it. Therefore let there be a water Wheel, as A, the which shall turn in a Case of Lead or Copper marked with C, the which case shall serve to keep the Water from scattering abroad and spoiling the motion, and the Axtree of the said Wheel shall rest upon two round holes, which shall be on the sides of the said Case, and at one end of the said Axtree which cometh through the same Case there shall be a Pinion of 8 Teeth, marked with D, which shall turn a Barrel of 12. or 15. inches; also there must be 3 conveyances for the wind, marked with E F G, to which there are Soldered 3 Cocks, whereof the Keys are made as M O, to the end that when the Barrel turns the pins Q and R they may make the said conveyances open to let the Air into divers Whistles, the which shall make several different Tunes, according to the Fabrick of those Whistles, and the disposition of the Pins and Touches Q and R. And moreover you may give a certain motion to the Tayls and Beacks of the Birds, if you put certain strings to the Keys of the Cocks: as the Figure declares.

As

As concerning the motion of the Owl, which turns forward and backward in a certain space of Time, the motion of it may be seen by the turning Vessel X, and the smal Lever 3, and 4. where there is the Counter-pois 8, for this Vessel descends when it is full, and makes the Counter-pois to rise, and the pin of the Lever stops the Barrel by means of the pin marked 6, which is at the end thereof, and so the Birds cease their Singing: then when the Owl shall be towards them, and when the Vessel X is void, shee shall turn again by the means of the Counter-pois, and the Barrel shall begin to turn: As the Figure will demonstrate to you very exactly.

The Explanation of Plate XV. An Engin by which Galata shall be presented, which shall be drawn upon the Water by two Dolphins, going in a right line and returning of her self, while a Cyclope plaies upon a Flajolet.

Let there be a water Wheel marked with L, the breadth whereof is separated in the middle, and that on one side the Boxes where the Water falls be made to turn toward the right hand, and on the other side they be made to turn toward the left hand: and to the Axtree of the said Wheel there is a Pinion which turns a toothed Wheel marked with Z, and the said Wheel hath an Axtree also divided into two parts, marked with I and H, and to the said Axtree are two Chains fastned, so that when the said Axtree turns, one of the said Chains may turn about it, and the other unturn; the which Chains pass about the Pullies G F, and are both fastned to the Pulley B, but one shall pass by E, so as when one turns the Axtree I H by the means of the water Wheel, the one of the said Chains may draw the said Pulley B towards the motion: but if the water Wheel be made to turn the other way, then the Chain which passeth through the Pulley E shall draw the Pulley B to it self, and the other Chain shall let it go in proportion: and as concerning the said Pulley B, it shall be put upon a Pipe of Copper, so as there may be a Plate of Copper under the said Pulley, between the two long stones C and D, so as the said Pulley may slide easily upon the said Stones. Then there shall be a smal Box of Lead or Copper marked with P, about a foot and a half long and broad, to which there is a Valve Soldered to the bottom, marked with R, and at the end of the base thereof a Pipe marked with N, and at the middle of the said Box, on the side there is a Pipe marked with O, and between the space of the said Pipe and the bottom of the said Box there is a smal Pipe which shall let Water into the Basin marked with S, Which shall be fastned to two turning Buckets marked V T, so as when the Vessels shall be full of Water, that it may be heavier then the cover of the Valve R, and on the contrary, when the said Vessel shall be void, the cover of the said Valve must be heavier, to the intent that it may shut and draw the said Vessel up, and so when the Water shall run into the said box by the Pipe V it shall rise up to the Pipe O, and fall upon the side of the water Wheel L, then the said Wheel turning, shall turn I, and consequently the Axtree I H, so as the Chain shall turn about I and unturn H, then the Figure of *Galatea* shall move towards the Pulley E, because it is drawn thither

ther by the said Chain which turns about the Axree I, the smal Vessel S must be so proportioned, that being fed by the smal Pipe, it may be full or near full and draw up the Valve when the Figure of *Galatea* shall be near the Pulley E, and then the Water which shall be in the said box, shall fall by the Valve upon the other side of the water Wheel, and make it turn the other way, so as the Chain H must turn about the Axree on the side H, and untun on the side I, which will be the cause to make the Figure turn toward the motion, and so the Pulley B shall be drawn (upon which the Figure is placed) sometimes forward, and sometimes backward, according as the double water Wheel shall turn, sometimes by the Water that runs by the Valve R, and sometimes by that which runs by the Pipe O, which is done divers times by means of the smal Vessel S and the turning Buckets T and V, for when the Vessel S is empty the Valve R is shut, and the Water riseth up to the Pipe O to make the water Wheel turn one way, and when S is full it opens the Valve, and then all the water falls by the Valve R on the other side of the water Wheel, which makes it turn the other way: and so successively.

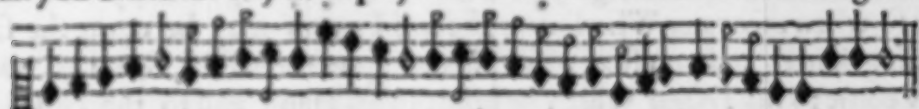
As concerning the *Cyclope* playing upon the *Flajolet*, the motion shall be shew'd in the following Figure.

It is to be noted that the little box marked with P, is here represented open on one side, so the intent to shew the Valve R.

The Explanation of Plate XVI. An Engine by which the Sound of the Flajolet shall be represented by the course of the Water.

Here shall be presented the Engine proper to make the *Flajolet* Sound to the *Cyclops* of the precedent plate: Therefore let there be a Musical Wheel marked with A, about 4 or 5 foot in Diameter, perfect round, and divided with Teeth, as you may see in the Figure, so as a Pinion of 8 Teeth marked with B may turn the said Wheel, and to the Arbor of the said Pinion there shall be a Wheel having 32 Teeth, marked with D, which another Pinion marked with C shall turn, and to the Arbor of the said Pinion C there shall be a water Wheel marked with E, about 2 foot and a half or 3, foot in Diameter, which shall be turned by the Water descending from the Pipe G, and so when the said water Wheel shall turn it shall cause the Musical Wheel to turn, by means of the other Wheels: afterwards there shall be put the Summer marked with H, the *Fabrick* whereof shall be shewn at large, so as the Keys of the said Summer shall be Parallel at half an inch distance from the Musical Wheel: afterwards divide the said Musical Wheel in 25, or 30. equal parts, each part in turning shall be an ordinary measure of Musick: and more-over all the said parts shall be divided into 8 equal parts, to put on Crochets upon each division, if it be required, of which there are 8 for one measure; and if you will you may put on Demi Crochets, or Quavers: afterwards the pins are to be put upon the said Wheel $\frac{1}{2}$ of an inch above the Superficies of the said Musical Wheel, so as when the Wheel shall turn, the said pins may touch the Keys of the Summer

mer and put them down and cause them to open the Valvs of the said Summer: as concerning the Pins they shall be put according to the Tune that you desire the *Flajolet* to play. That which is here set down begins thus,



And when you would change the Tune, it may be done by dismounting the Pinion B, out of the Musical Wheel by means of the Rest of Iron, upon which the Pinion shall be put, and loosning a final Screw which holds the said Rest in its place, then the said Rest being drawn from its hole, the said Pinion shall be disjoyned from the Musical Wheel, which may be turned with the hand: you may fit any other Tune upon the said Wheel: the 12 holes that are in the Summer serves to convey the wind of the said Summer by the conveyances of Copper or Lead, to the *Organ Pipes*, to represent the Sound of the *Flajolets*, all which shall be joyned to the Figure of the *Cyclope*. The construction of the said Pipes shall be taught hereafter: the hooks which hang at the Cords P O, serve to draw up the Musical Wheel, that if there be any fault in the Valves within the Summer it may be helped by opening the said Summer before, as is done ordinarily, the great conveyance marked with S may be of Wood 4 inches square, to conduct the Wind to the Summer, which shall come from the Bellows, as shall be taught.

The Explanation of Plate XVII.

IN this Plate is represented the Figure of *Neptune*, which shall turn Circularly with certain Trytons, and other Figures, which shall cast forth Water in turning. The Wheel work belonging to the motion of these Figures shall be declared in the following Plate.

The Explanation of Plate XVIII. This Plate declares the motion, and Wheel-work of *Neptune*, and other figures represented in the foregoing Plate.

Let there be a water Wheel marked with A, which turning, shall turn a Toothed Wheel marked with B, the Pivot whereof shall rest upon a straight peece of wood, and the Arber above marked with P Q, shall be fastned firmly to a Pipe of Copper marked with S R, and at the end thereof there shall be a smal Receiver, where the water shall fall: Then there shall be a great Pipe marked with T V, which shall be also fastned to the Arber, a little lower then R, so as the said Pipe may turn upon another marked with pointed lines which shall be interlaced (marked also with pointed lines,) and the said great Pipe, and that in the middle shall be Soldered firmly to the bottom of the Reserve of Lead maked with C D, and the great Pipe X V shall be Soldered to a great Wheel marked with E F, which shall be within two inches of the bottom of the said Reserve, so as when the Wheel below B turns, the said Wheel E F may also turn, because they are

K

fastned

fastned in one common Axtree: then on the top of the great Pipe there shall be another small Pipe marked with G H, which shall be Soldered against R, so as the Water Descending by the said Pipe may spring forth by the end H, and so when the water Wheel turns, the said Figures may be upon the said turning Wheel; and you may place Neptune upon the end H, so as the water may come to his Trident which he holds in his Hand, and to the Noses of the Horses which draws him, and the two Tritons upon M, and the Cupid which leads the Dolphins upon N: And you may likewise put certain other Figures upon Z; and to the intent to cover the Pipe which descends from S to the Base of the Reserve, you may make a Rock, as you may see in the foregoing designe, which may descend from the top of the Grote where the said motion shall be, almost to the bottom of the Reserve, without touching it, nor also any of the Pipes, to the end that all may turn freely, and the Reserve must be alwaies full of Water a foot high, to the intent that you may not see the motion of the Wheel E F in turning.

The Explanation of Plate XIX. An Engine by which you may make a paire of Organs to Sound by the means of Water.

THis Engine is very like to that demonstrated in the 16 Plate, the difference is that, this here is seen fore-right, and that other upon one side: the Musical Wheel marked with A may be of five or six foot in Diameter, which shall be turned by a Pinion of eight Teeth, to the Axtree whereof shall be fitted a Wheel of twenty four Teeth, Which shall be turned by a Pinion on whose Axtree the water Wheel C is fastned: the Keys are marked with D, and the Summer with F: the construction whereof shall be taught afterwards: the three Registers marked G H I, are different the one from the other. And to the intent that the noise of the motion may not be heard when the Organs play, it is good that there be a wall of a foot thick between the Registers and the said motion, the conveyances of the wind are of Copper, which coming from the Summer to the Registers pass through the said wall.

As concerning the Bellows to give wind to the Pipes, the motion of them shall be shewn in the next Probleme, and also how to put the Musick upon the Musical Wheel.

The Explanation of Plate XX. An Engine by which the Bellows of the foregoing Engine may be lifted up to give Wind to the Pipes of the Organs.

THere are two manners to give Wind to the Pipes of the Organs in Hydraulique Instruments, the one is with Bellows made with thin Boards joyned together with Leather, the other is with the Air which comes from Cisterns by want of Vacuity, as shall be taught hereafter. At the present I will shew how to raise the said Bellows by means of a water wheel, as you may see by this present designe, where the long branch of Iron or Copper divided

divided into four turning handles, make the said *Bellows* to rise the one after the other, by means of the said water Wheel.

The Explanation of Plate XXI. The representation of the Musical Wheel, to serve for Plate 19.

TO demonstrate Intirely the Engin of Plate 19. I will put here the representation of one part of the Musical Wheel as big as the natural, to the intent that you may perfectly see how the Pins put down the Keys of the *Organ*: the said part doth onely represent six measures, the one of which shall be marked with Black or Gray all along the said Wheel, and the other shall be marked with White, to the intent that the divisions may more easily be discerned, which shall be Parallel to the Keys: and if you will you may pierce the holes upon each division to change the Pins, when you would change the tune: Then you shall put the said Pins so as they may touch upon the Keys about the thickness of one of the said Pins, and so as the one touch not harder then the other. Alwaies when you come to *Demis-Crotchets* or *Quavers*, which of these are sixteen in one measure, it will be good that they do not touch so hard as the others, to the end that one Pin do not touch before the other have passed beyond the Key, which is to be observed in all the other measures, otherwise there will be a confused Musick.

As concerning the construction of the Musical Wheel, it is necessary that it be of Oak, very dry, and the peeces well Joyned and Glued together, to the intent that it do not swell neither on the one side nor on the other: As for the Pins they shall be of Brasse or of hard Wood. Furthermore you shall observe that in this present Figure, there is but half the Keys designed: also many of the notes are wanting to the said Figure, because the Paper was not large enough to draw it so large as the Natural: but that which is here designed may serve to give understanding to the rest.

The Explanation of Plate XXII. To make Organs, or Trumpets of Organs, to Sound alwaies when the Sun shall be South, without any other principle of motion, but the heat of the Sun and the Water.

Let there be a Vessel of Copper or Lead marked with A, very close and Soldered on every side, and let it have a Syphon marked with C, which may be so made that the end which is within the Vessel be near to the bottom, and that the height of the said Pipe or Syphon be near the height of the said Vessel, then the other end shall come forth of the Vessel to run into the Vessel D.

And to order it so as the Sun may not heat the Vessel A till Noon; Behold how you are to proceede: Let there be a Tablet made to the said Vessel of strong Lead or Copper, marked with B, (as if it were the Cover of the said Vessel half lifted up) well Soldered to the said Vessel, and let the said Vessel be Invironed with a smal Wall of Brick, so as there may be

onely the side before open to the Sun, and that the said side be exactly placed toward the South. It is certain that this being well done, that the Sun shall not shine against the said Vessel, but just at Noon; and then the rays shine against the angle which the top of the Vessel makes with the Table B, and by that means heats the top of the said Vessel, which shall make a compression in the Vessel, so as the water shall run forth by the Pipe C. Let there also be made a great Vessel marked with F, into which the water of the Spring which is to make the motion runs continually, and at the bottom of the said Vessel there is a Valve marked with G, at the lower end whereof there is a Pipe with a Cock marked with H, which serves to temper the course of the Water, which shall fall upon the water wheel which is below.

So when the Sun shall be directly South (as hath bin before said) his rayes shall shine against the Vessel A, which shall cause a compression of the water which is within, which shall run forth by the Pipe C into the Vessel D, which being half full shall descend and open the Valve G, which being open the water of the Vessel F shall run upon the water wheel and make the Musical Barrel to turn, as hath bin shewn before; and the Pins that are put upon the said Barrel, shall touch the Keys M, which being put down shall open the Valves which are under the Summer X, and the wind that shall be in the said Summer, shall make the Pipes of the Organ or Trumpets Sound which are above the Summer. Now Wind may be given to the said Summer after two several manners, that is to say, by a Reserve, which is filled with the water which falls upon the water Wheel, or by Bel-lows which are raised by another water wheel, which shall move when the Vessel D descends, and shall open also a Valve, as that is marked with G: but because the Instrument must stop just at the point where it began, (when the Musical Barrel hath made one turn) to the end that when it begins to Sound another time, the Musick may be of a just measure.

Behold how it is made to stop. You shall make a small Vessel of Copper marked with E, which shall have a small hole in the bottom, and shall be so placed that the Cord which holds it shall be fastned to a ring near the Valve G, and the water which shall fill the said Vessel shall be conveyed by the Pipe marked with L, so as when the Valve G is opened forth with the water shall run into the said Vessel, and when the water of the Vessel F, shall be a little abated, then it shall run no more into the Vessel E, which shall alwaies empty the water which is in it by the small Hole at the bottom. And the time that the said Vessel E empties must be fixed to the time that the Wheel requires to make one turn, and the said Vessel being empty the Valve G shall fall down again, because it ought to be made in a manner heavier then the two Vessels E and D, when they are empty: and on the contrary, when one of the said Vessels is full, that they may be Heavier then the said Valve: And as concerning the Vessel D it is necessary that it empty rather then E, because it need not keep so exact a measure as E. And see here how it empties, when it is half full with the Water which descends by the Pipe C, then it draws down it self, and that marked with E, also because it is Heavier then G, and at the same instant G opens, and the water descends upon the Wheel and into the two Vessels, and when D is full then

then the Vessel turns the top downwards and empties, and in the same time the water of the Vessel *F* abates and is lower then the height of the Pipe *D*, the water shall run in no more, but the end of the Pipe *L* must be somewhat lower then that of *D*, to the end that the water may there run longer. It remains to shew how the Pipe *A* is filled again with water:

Therefore let there be put a Pipe with a smal Valve under the said Vessel, after the same manner as in the foregoing Figure, and after that the Heat of the Sun hath made the compression, and that one part of the water of the said Vessel shall be run out after the Sun hath passed the said Vessel, to shun Vacuū it shall fill again by the said Valve as hath been taught in the 14th Probleme.

In Sum, if all the parts of this motion be well ordered, you shall have the desired Effect with admiration to the Hearers.

The Explanation of Plate XXIII. To make an admirable Engin, the which being plac'd at the foot of a Statue, shall send forth a Sound when the Sun shineth upon it, so as it shall seem that the Statue makes the said Sound.

Cornelius Tacitus in his Hist ry maketh mention that there was in Egypt a Statue of Memnon, which did send forth a certain Sound, when the Sun shined upon it. Pausanias is said to have seen the said Figure, and that the Sound was like to the Sound of the strings of an Harp when they break.

The Demonstration of this present Figure doth arise from that which hath been shewn before in the 9th and 10th Plate, which teacheth to raise the water in a Vessel of Copper or Lead (with the Heat of the Sun) by means of a Valve *A*. Now when the water shall be in *F*, it shall be transported into *C* by the Syphon *B*, which casting its water into *C* shall make the Air breath forth of it, and animate the two Organ Pipes, which with the Engin may be put in the Figure or in the Pedestal, or otherwise, if the Engin be put at a distance you must use conveyances for the wind, and so the Pipes may be in the Figure, which being of Brass and holow shall have no Air but by the mouth by which the Sound of the Organ Pipes shall come forth.

The Explanation of Plate XXIII. In this Plate is Figured the inside of the Musical Summer, for the Organs or Hydraulique Engins, which we have spoken of before.

The Summer which is spoken of in the 16th and 19th Plate is here (for more easie understanding) represented three several waies, that is to say, By the Plane or Iguography, by the Orthography or Profile, and by the Senography or Perspective: the Valves are marked with *M*, the Groves by *E*, the Springs by *H*, and the Keys by *L*.

As concerning the Covering of the Summer and Valves, and the matter of the Summer which ought to be of Oak, well dried, we might say divers things, and extend it more at large, but I think that it is not here needfull, I

will only add that which the excellent *Poet Dubartas* saith upon this Subject in the following Verses.

Dubartas
fol. 181.

*Where, as (by Art) one silfly Blast breath'd out
From panting Bellows passeth all about
Wind Instrument, enters by th' under Clavers
Which with the Keys the Organ Master quavers,
Fills all the Bulk, and severally the same,
Mounts every Pipe of the Melodious Frame.
At once reviving lusty Cymbals Voice
Flutes sweetest Air, and Regals shrillest noise.*

But concerning the *Systemes* and *Measures* of the *Organ Pipes*, both in *Length* and *Breadth*, *Covered* or *Open*, and also of the manner of the *Registers*, great conveyance of the *Wind*, and the *Trembling stop*, &c. Is referred to a particular *Treatise* of the *Construction of Organs*.

The Explanation of Plate XXV. A Sluce to render falling Waters Navigable:

AMong all sorts of *Sluces* which may be produced to retain the *Water*, and render *Rivers* and likewise small falling *Waters* *Navigable*; I have observed this here to be the most excellent:

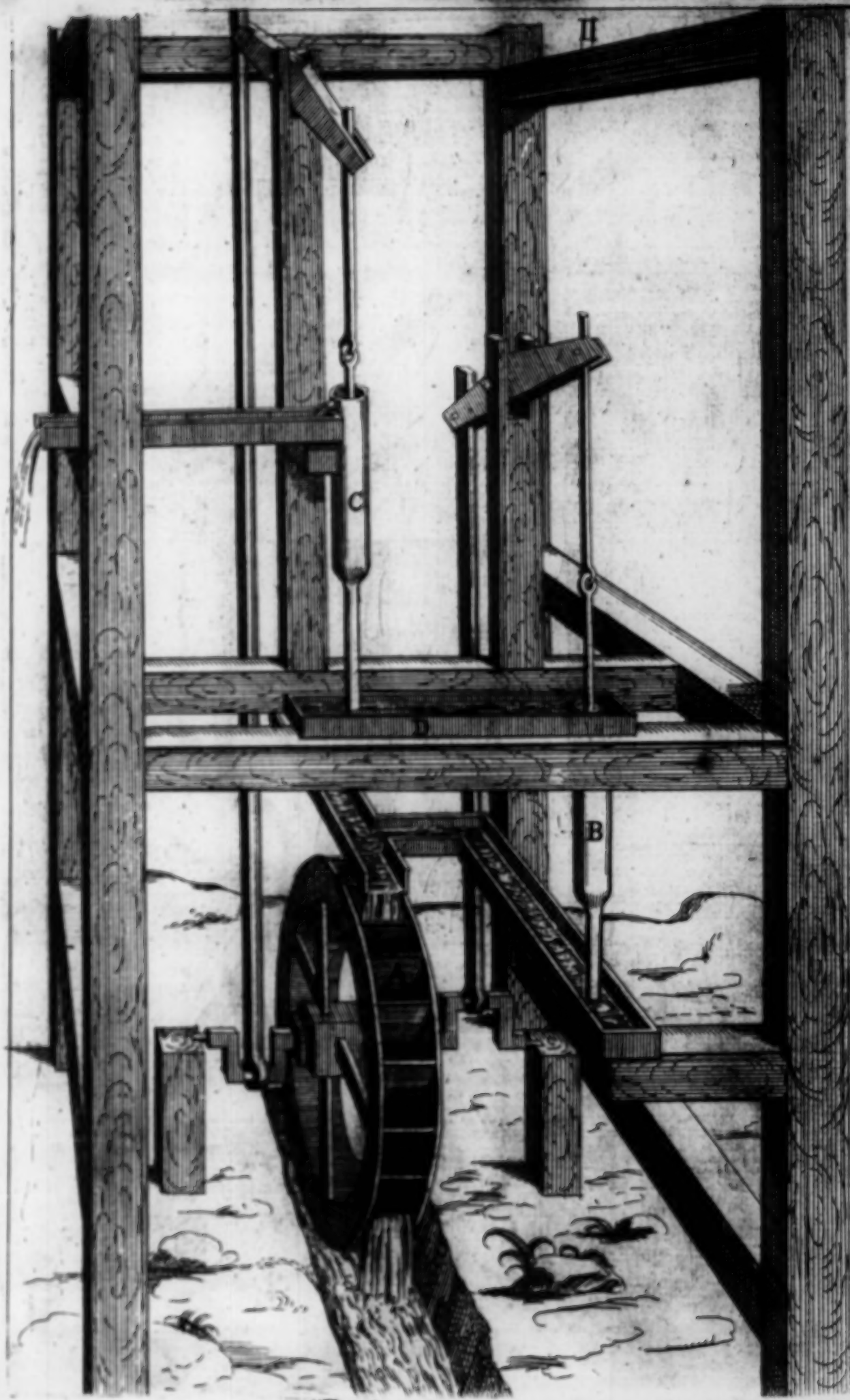
It is placed between *Venice* and *Padua*, upon the falling water which is between the two *Cities*, which by *Art* hath been rendered *Navigable* for the facility of coming between the two *Towns*.

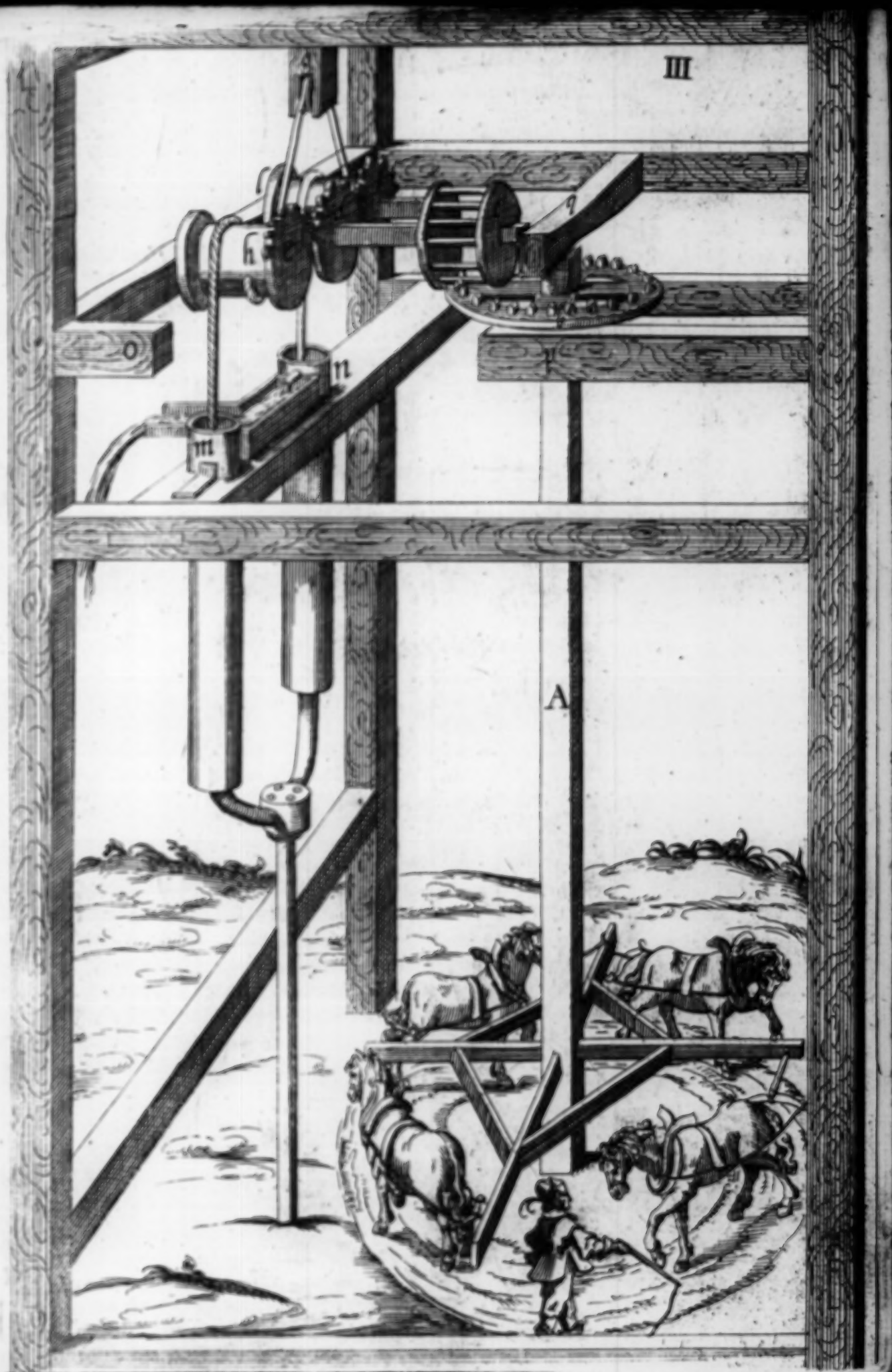
It is to be observed that the water *A* which is towards the *Spring* or *Head* of the falling *Water* is always very much higher then the water *B*, which is at the bottom of the second *Sluce*: Now to make the *Boats* and *Barges* *Ascend* or *Descend*, they are tyed to an *Iron ring* during the time that the *Water* contained between the two *Sluces* *Rises* or *Falls*; let it be either to *Ascend* towards *A*, or *Descend* towards *B*. The *Ingenious Reader* may easily see the effect of these *Sluces*, without more words, and making other description then that which is described in the *Figure*.

The Explanation of Plate XXVI.

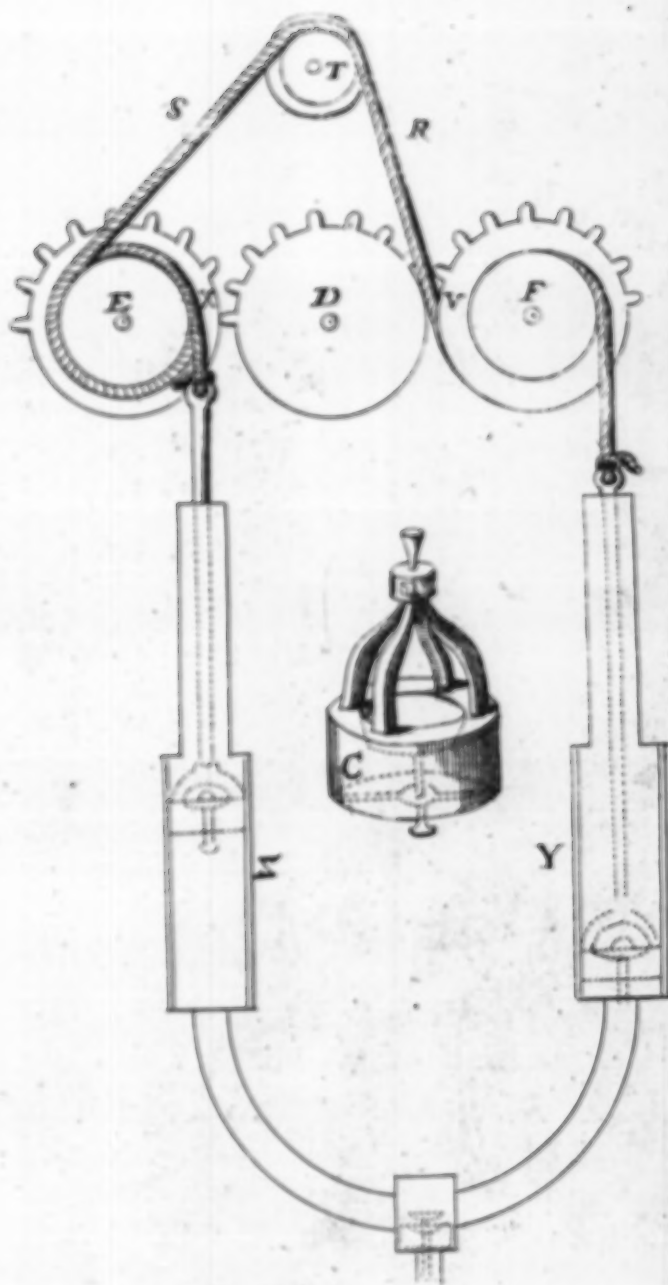
BESIDES that which hath been handled before concerning *Pumps*, I have thought good also to add this manner of *force-Pump*, which is one of the best *Inventions*, and of which I have seen the experience: That which is here of great advantage, is that the forces do *Rise* and *Fall Perpendicularly* in their *Barrels*: It is easy to comprehend by the *Figure* that there are four places in the *Arbes* which are *Hollowed* or *Channelled*, and in the half of the *Channels* there are *Pins A E*, incountring with *Pins* which are in *P H*, they make them to *Descend*, and in *Descending* they raise *B N* without being hindered by the *Pins* that are therein, because they pass by the void place of the *Channels* marked with *D C*, and so they rise and fall each in his turn, and force the water with great violence to 50, or 60, foot height, or higher, if it be required.



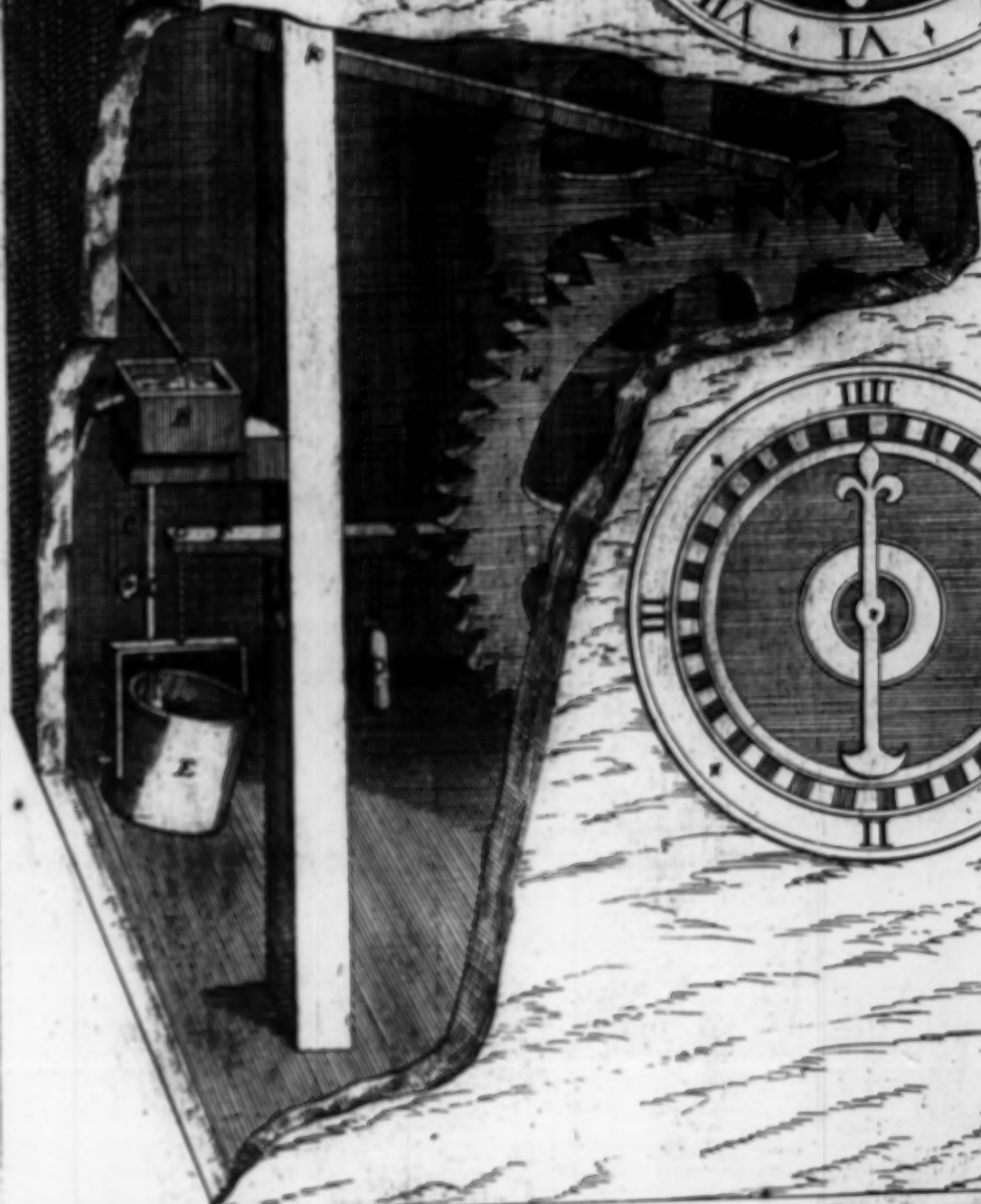


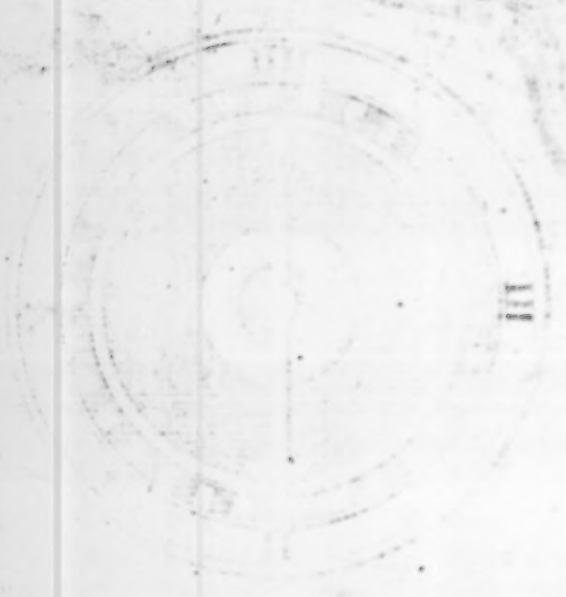


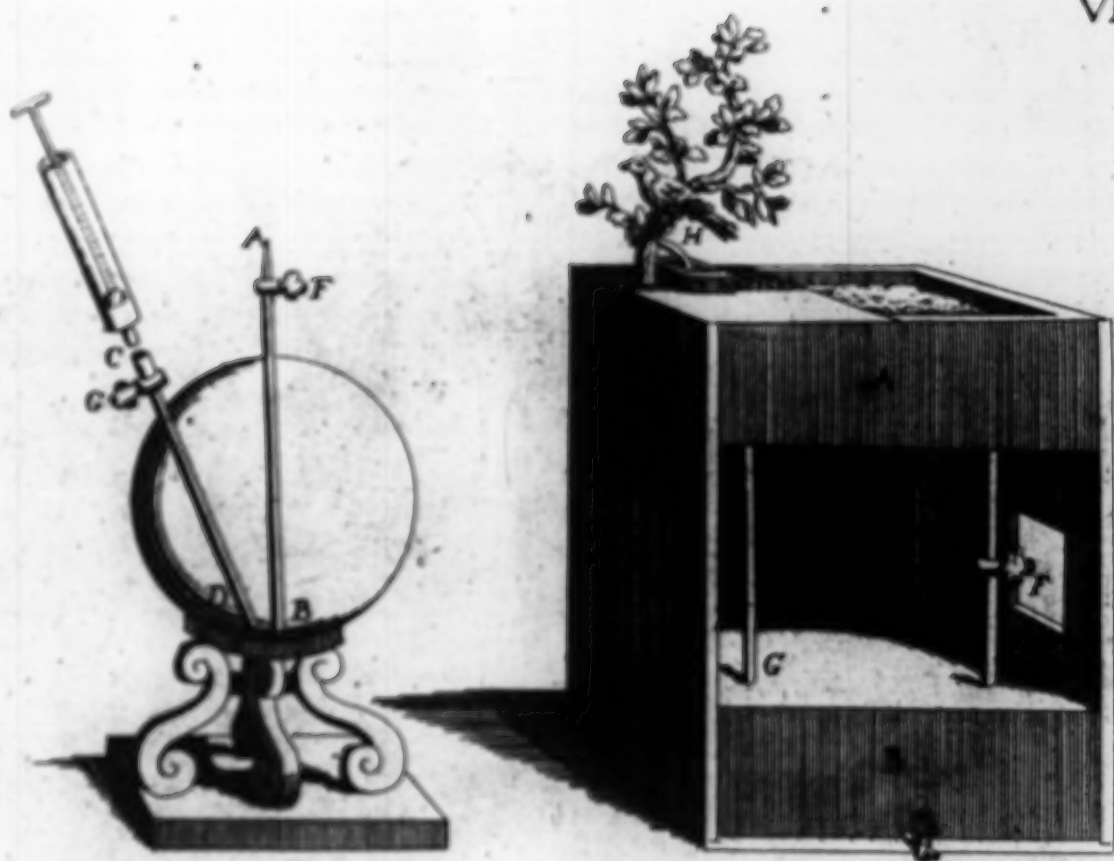


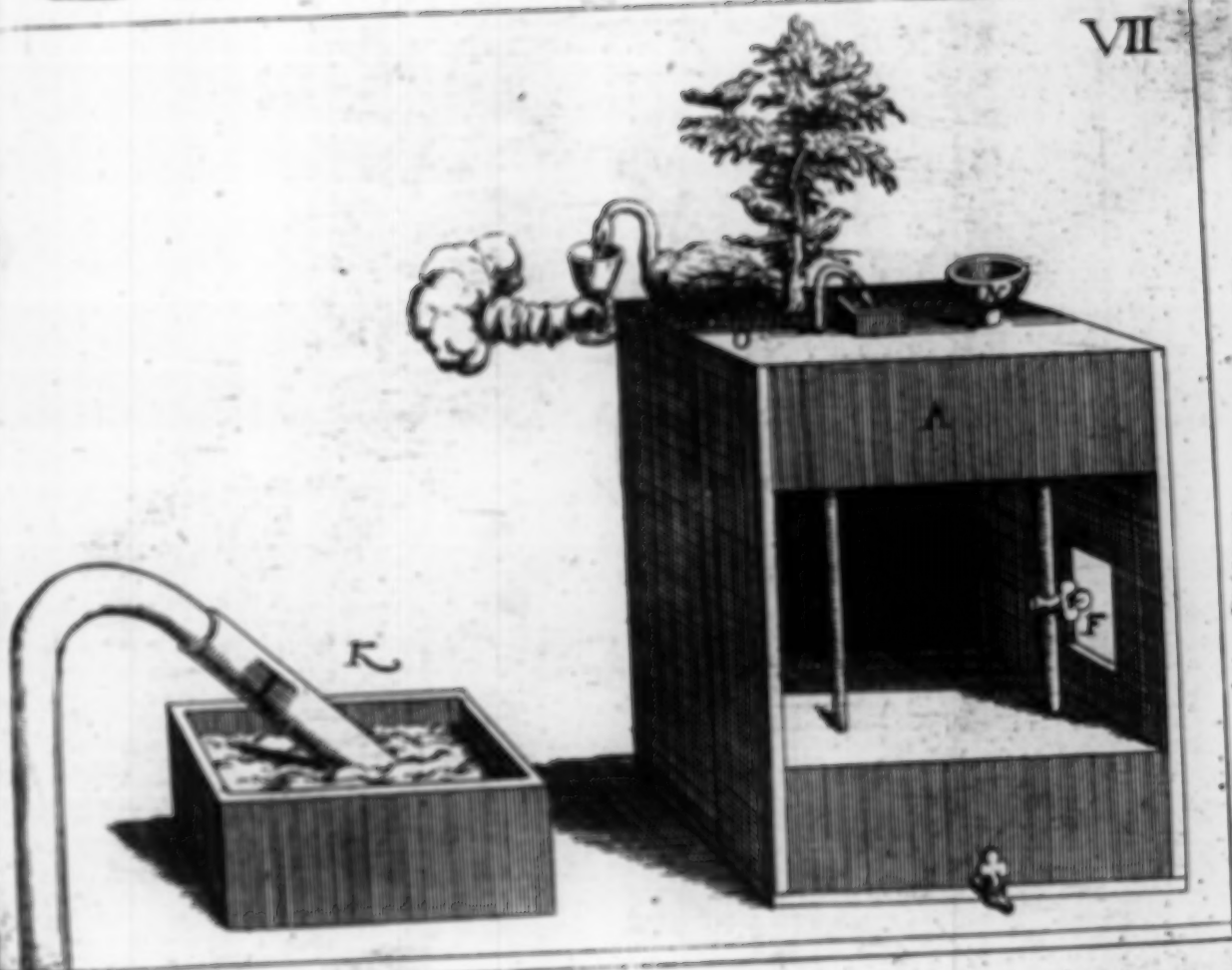


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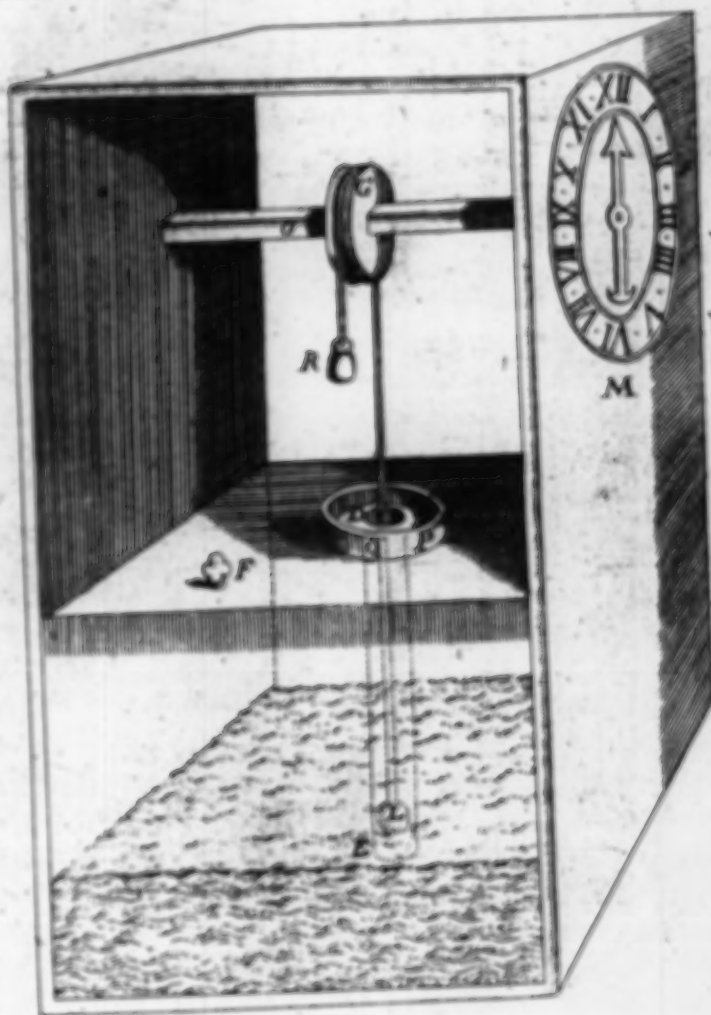




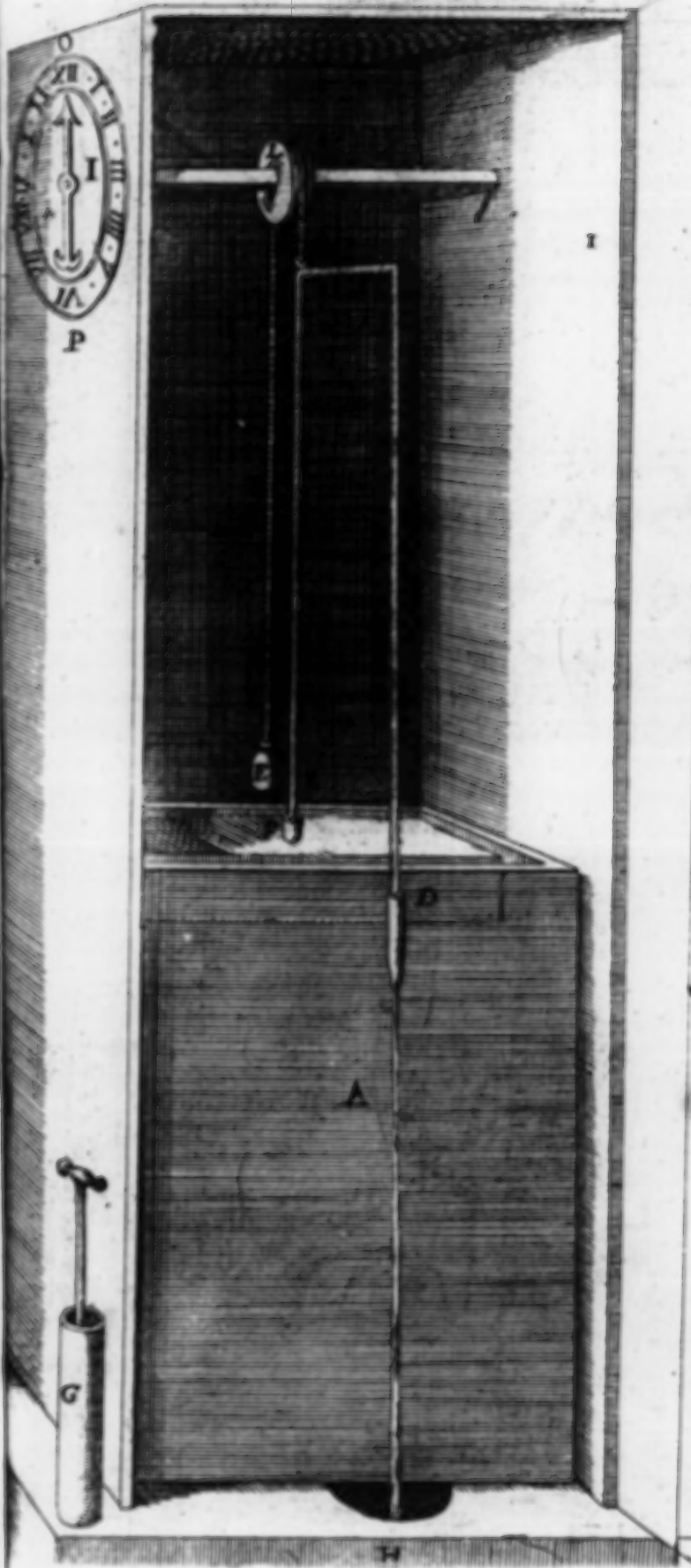
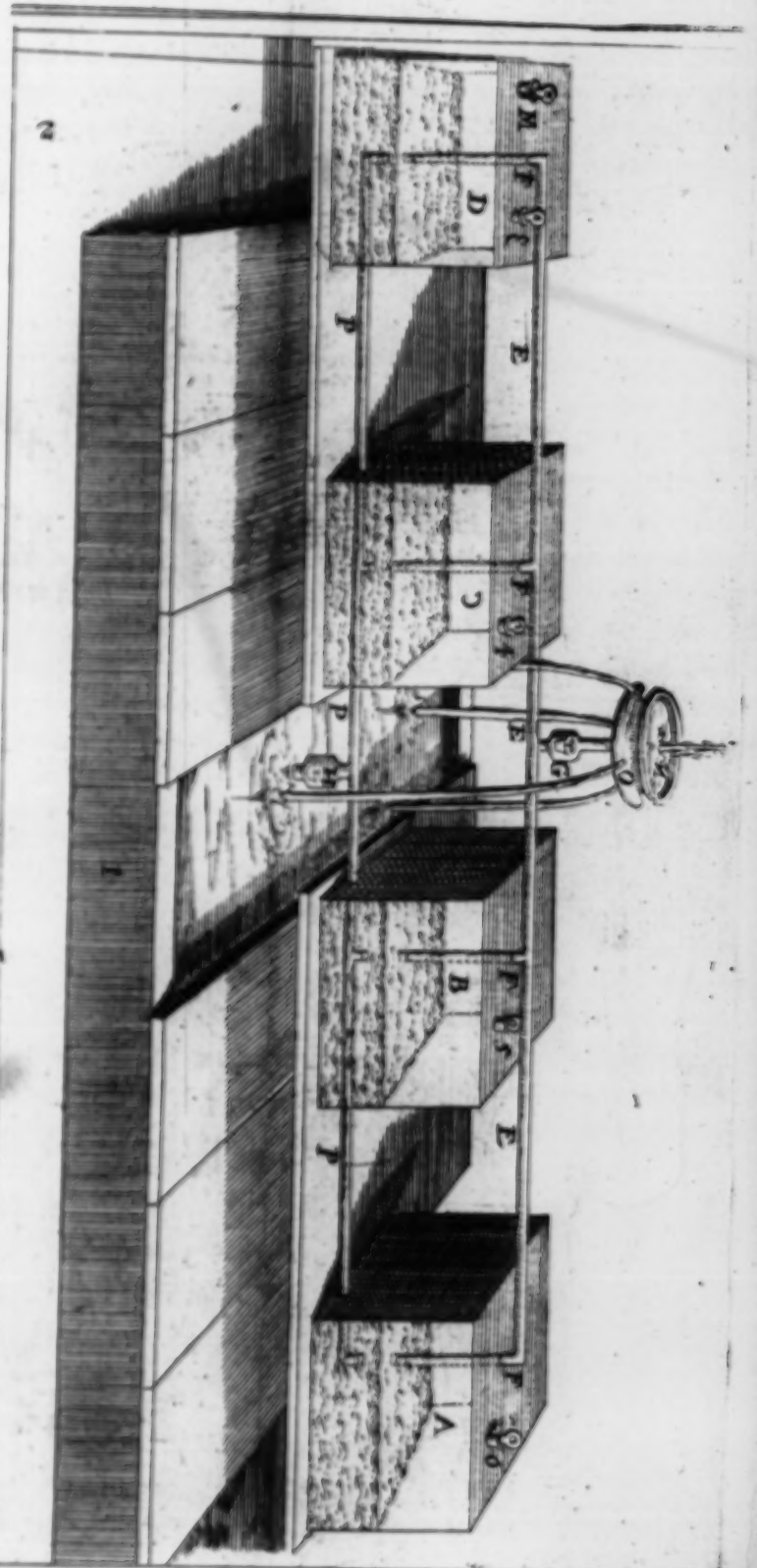




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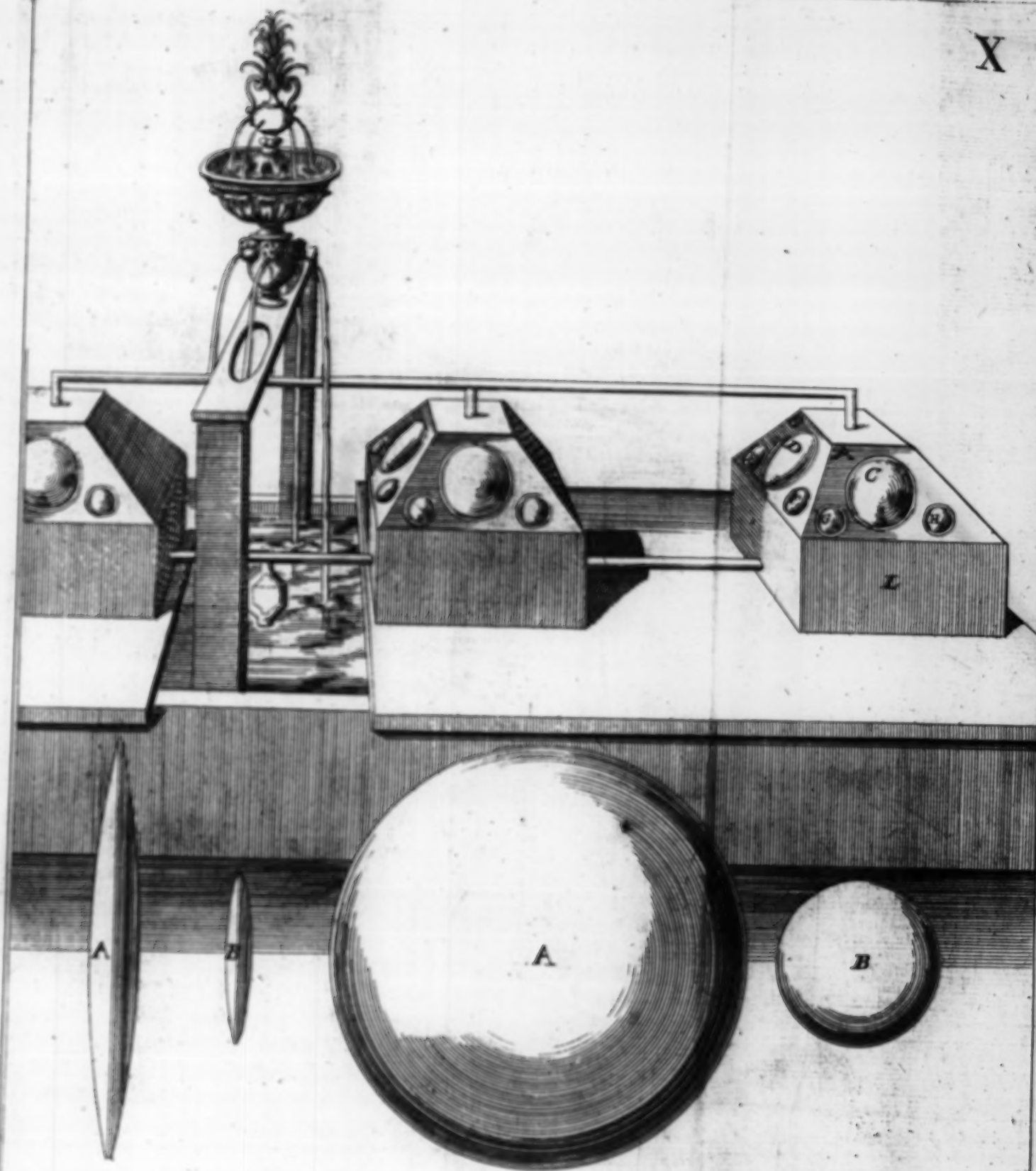


III



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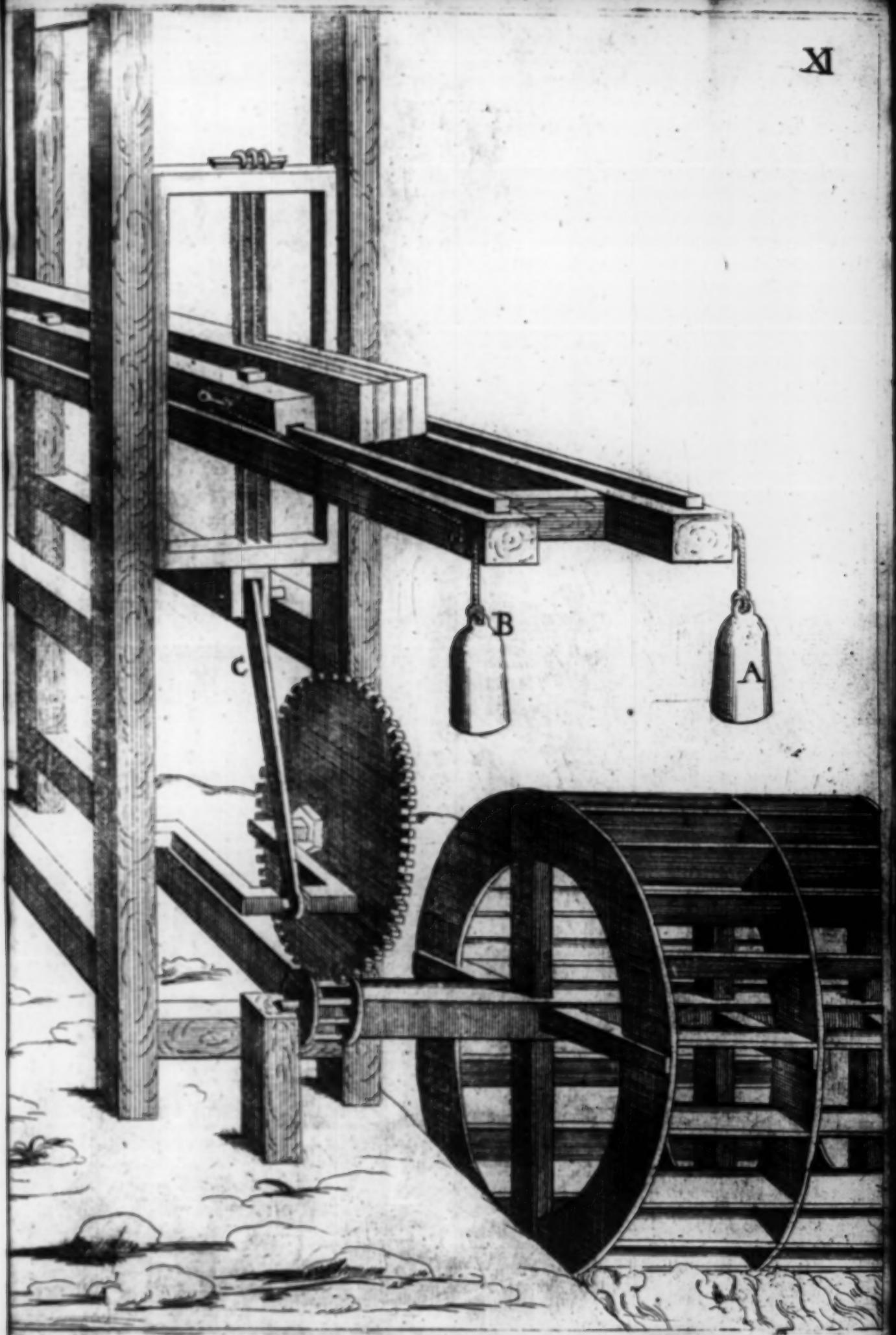
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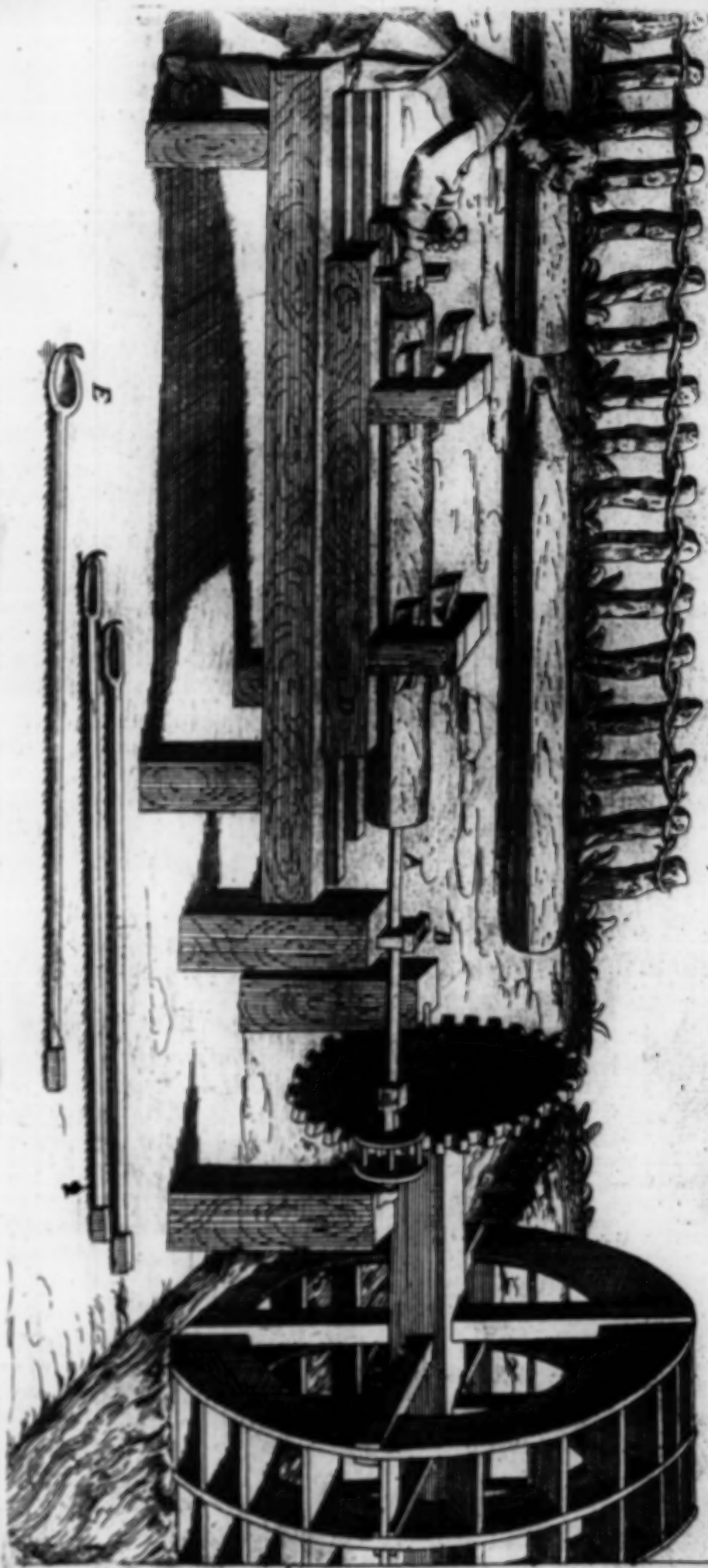


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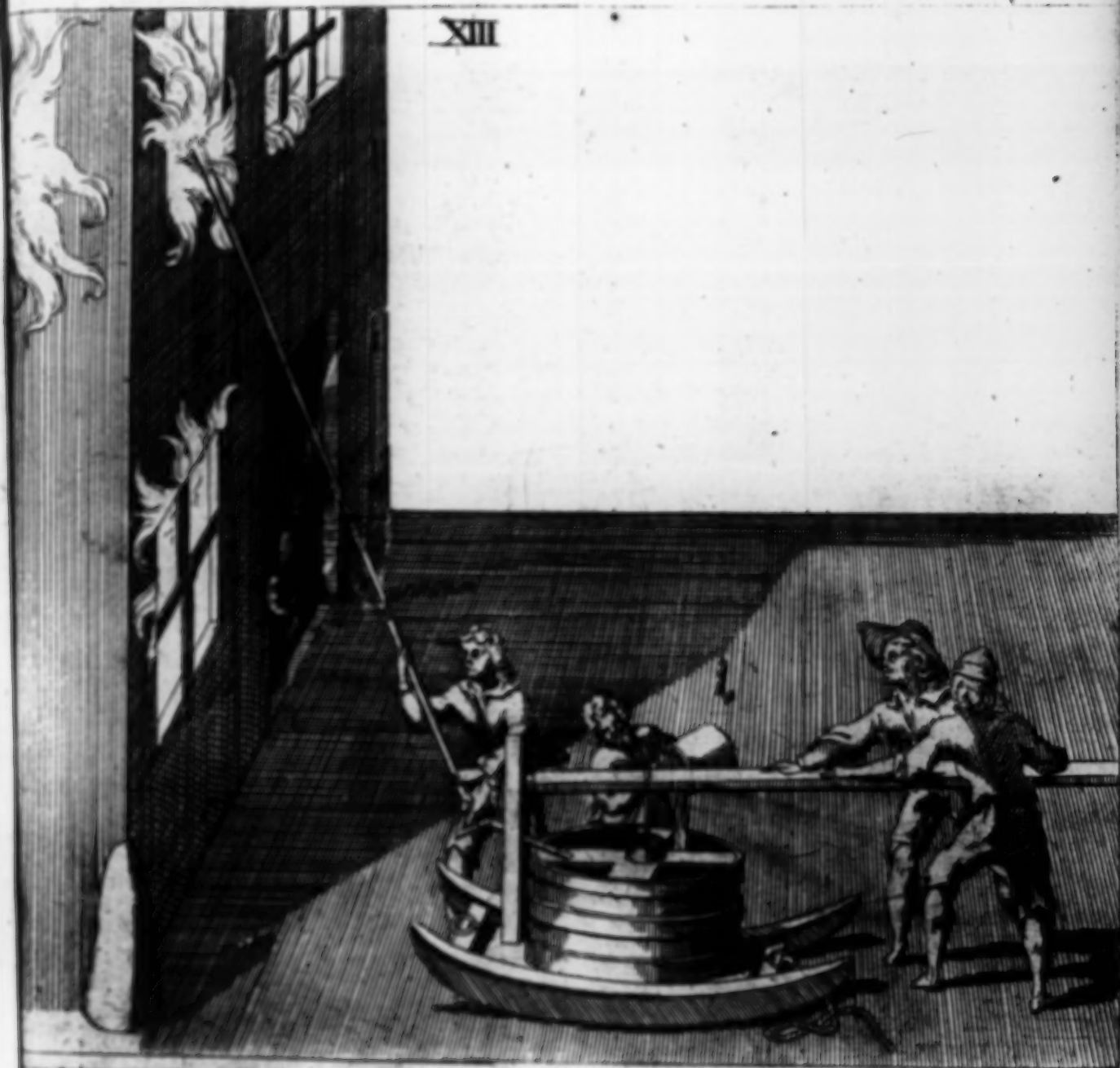




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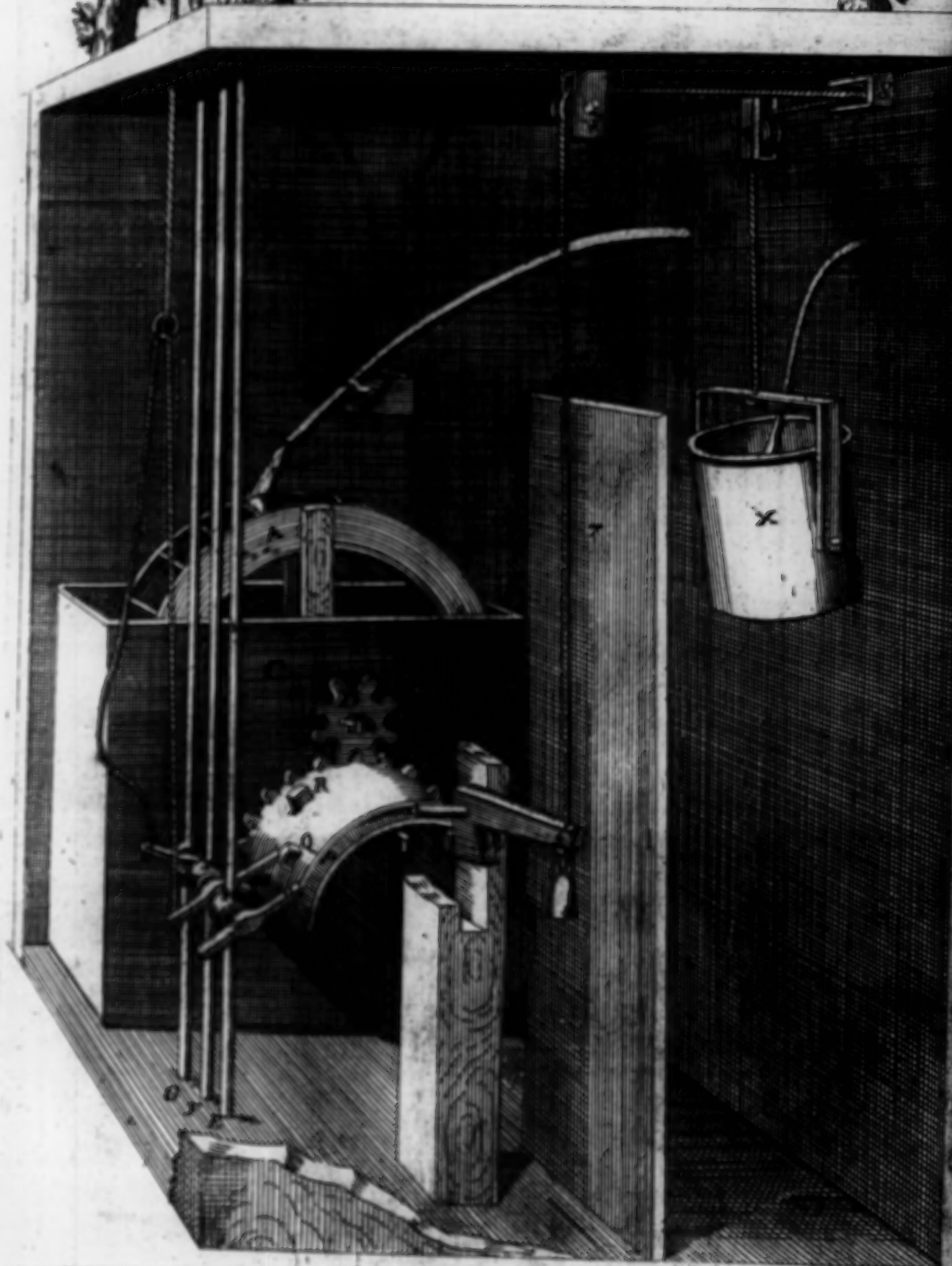


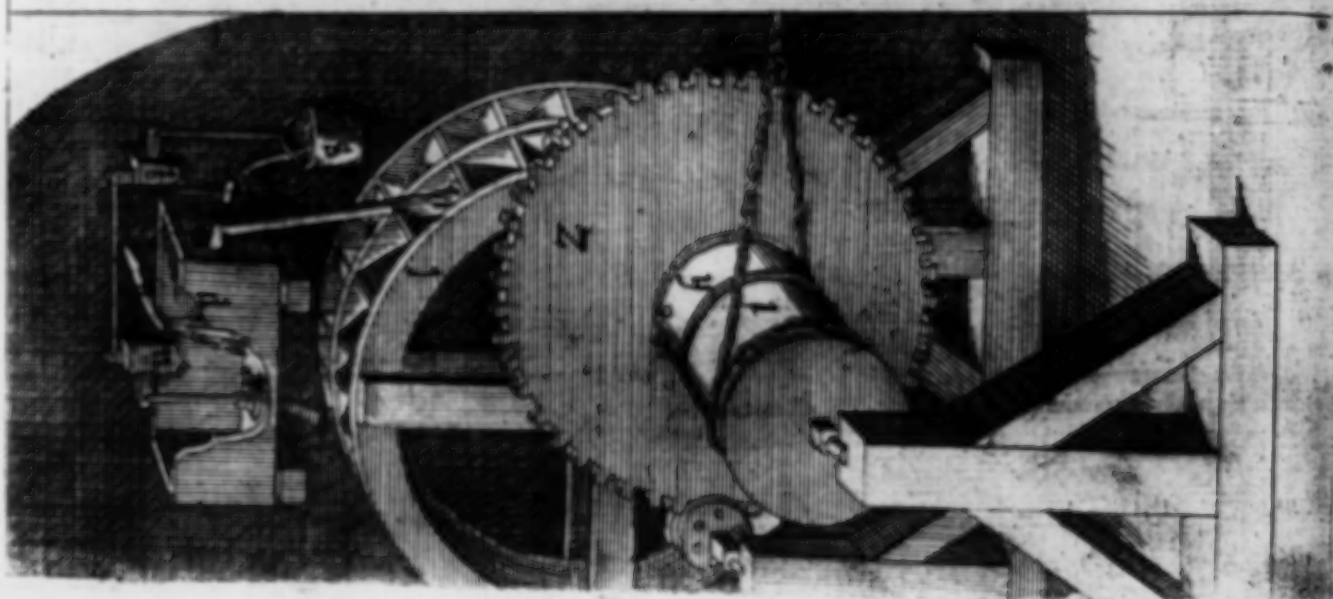
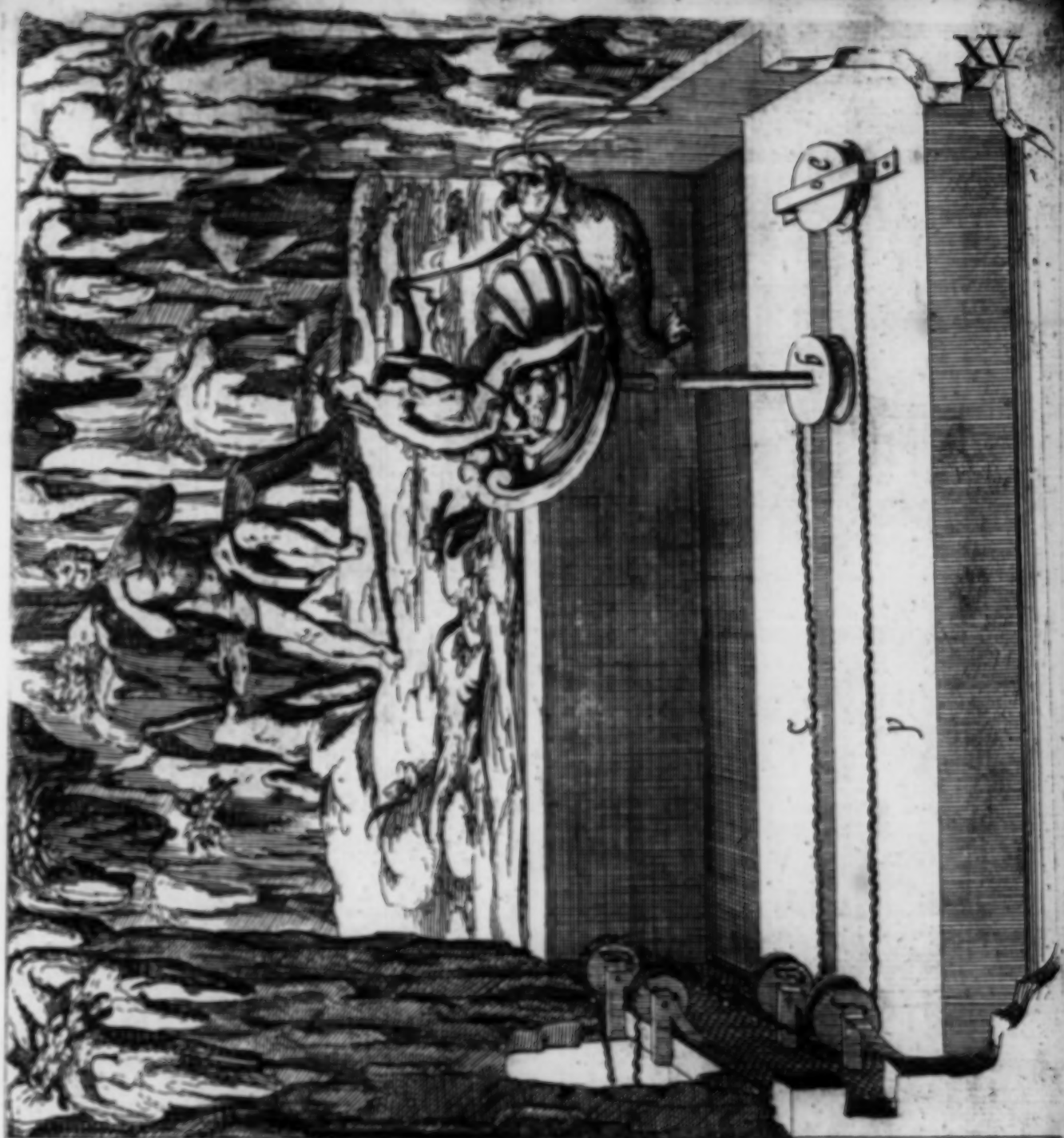
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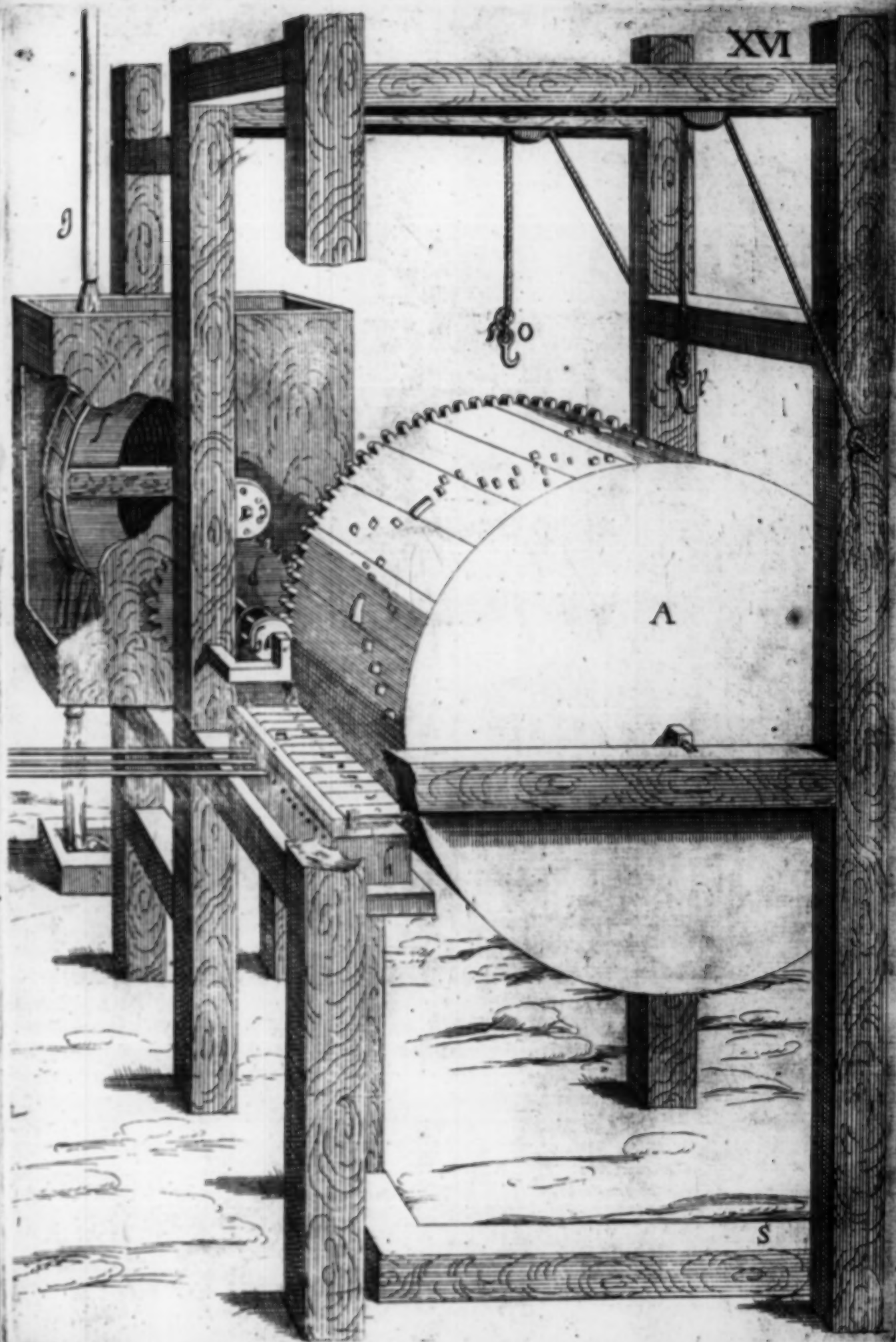
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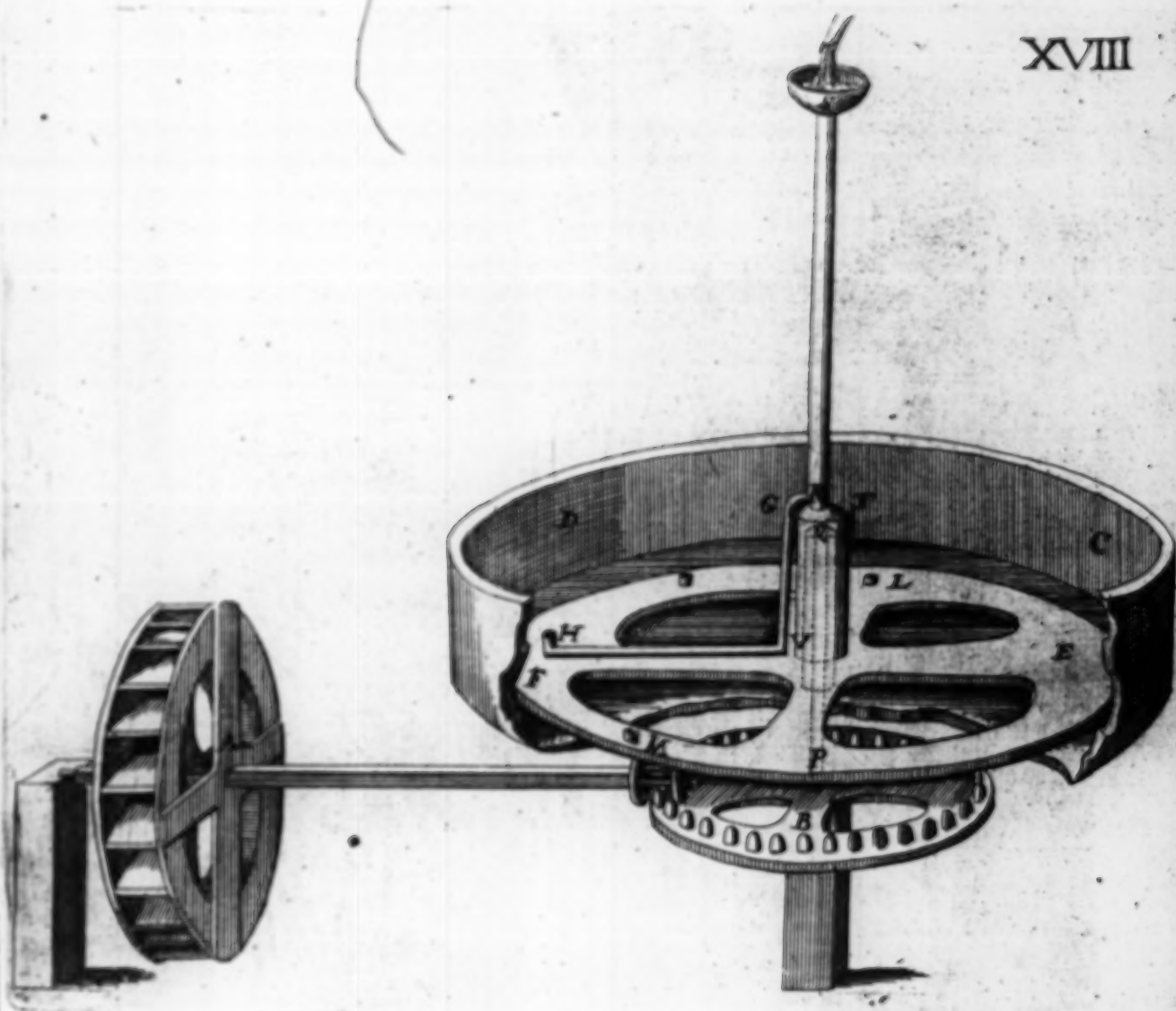
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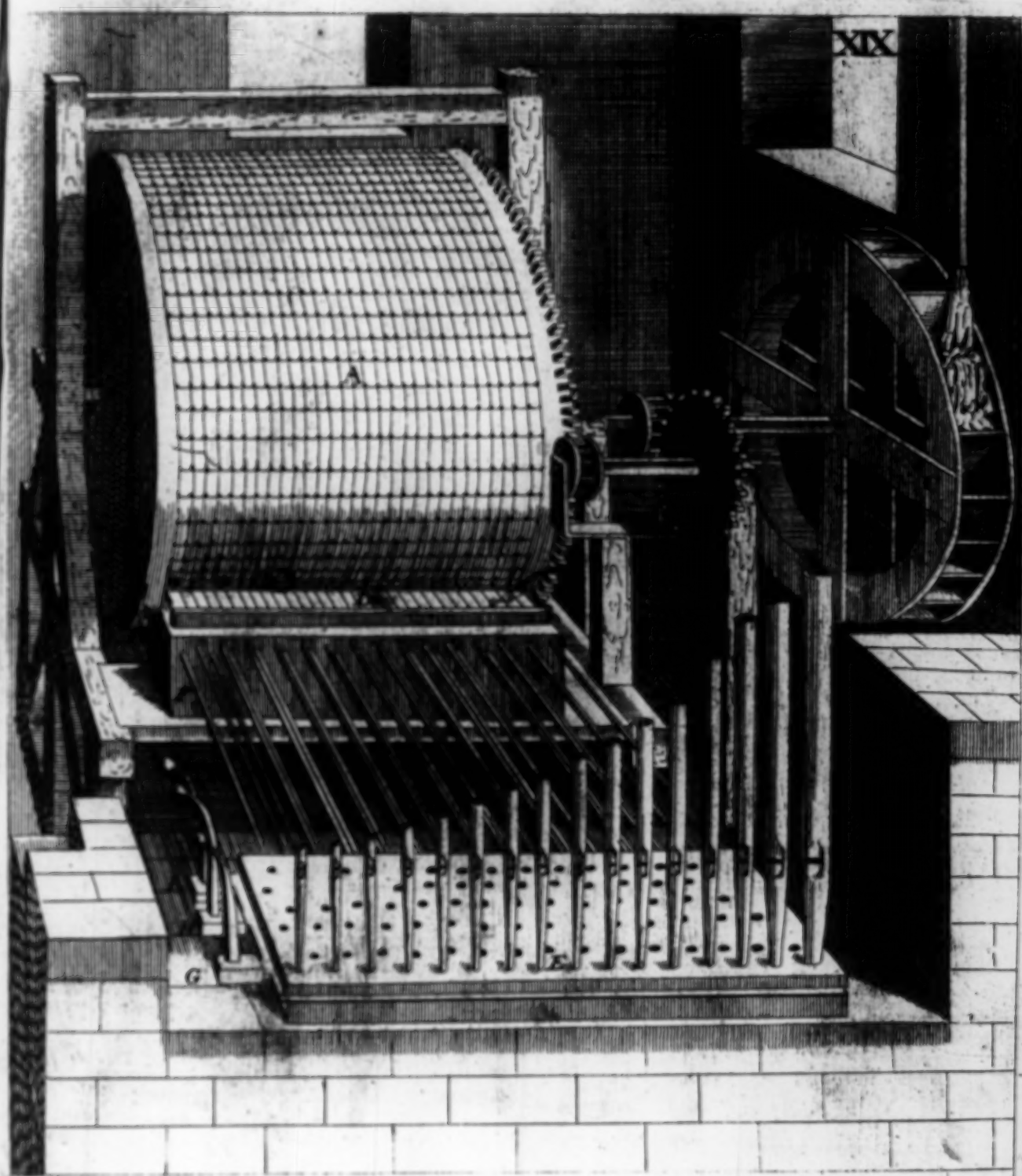




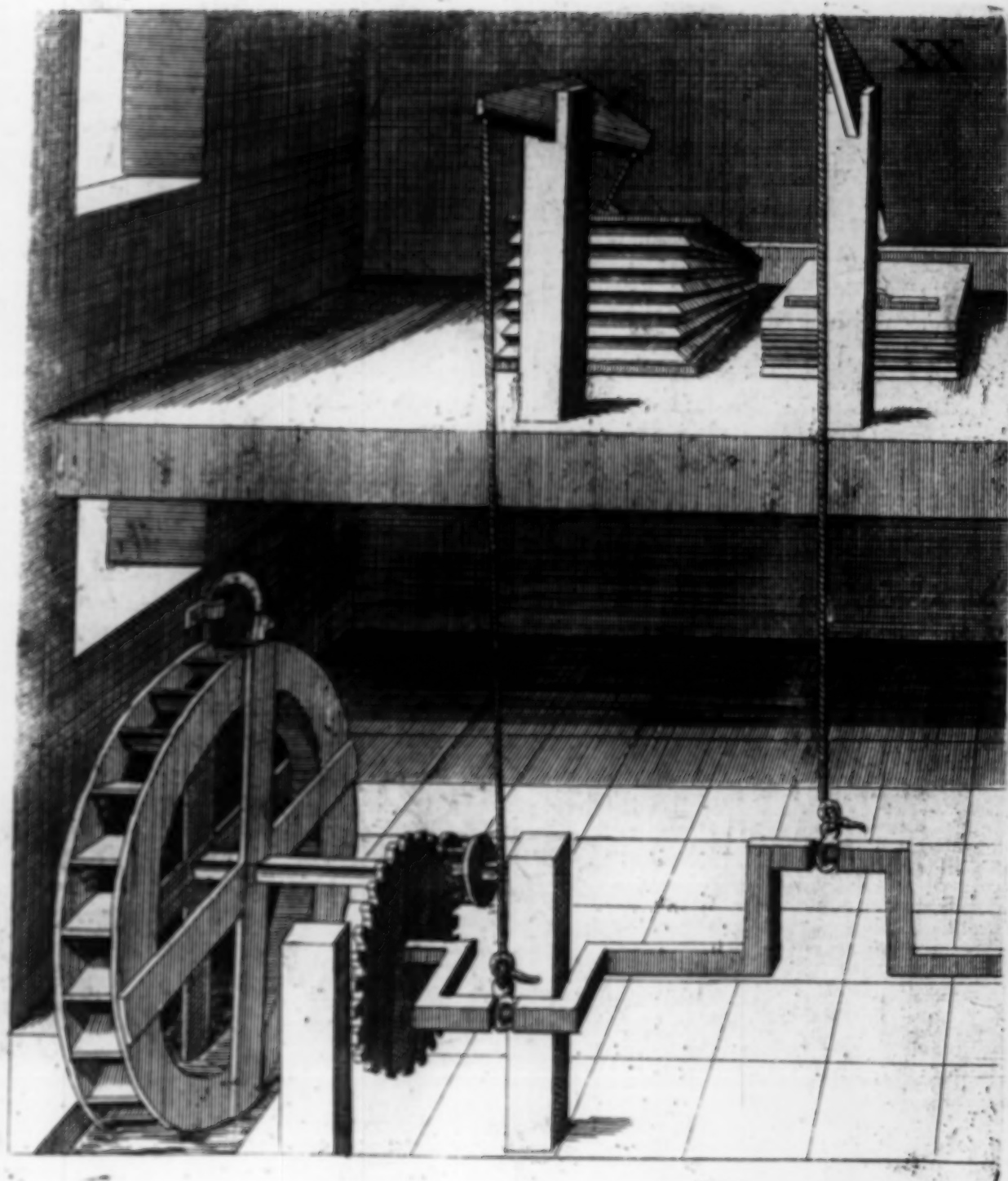
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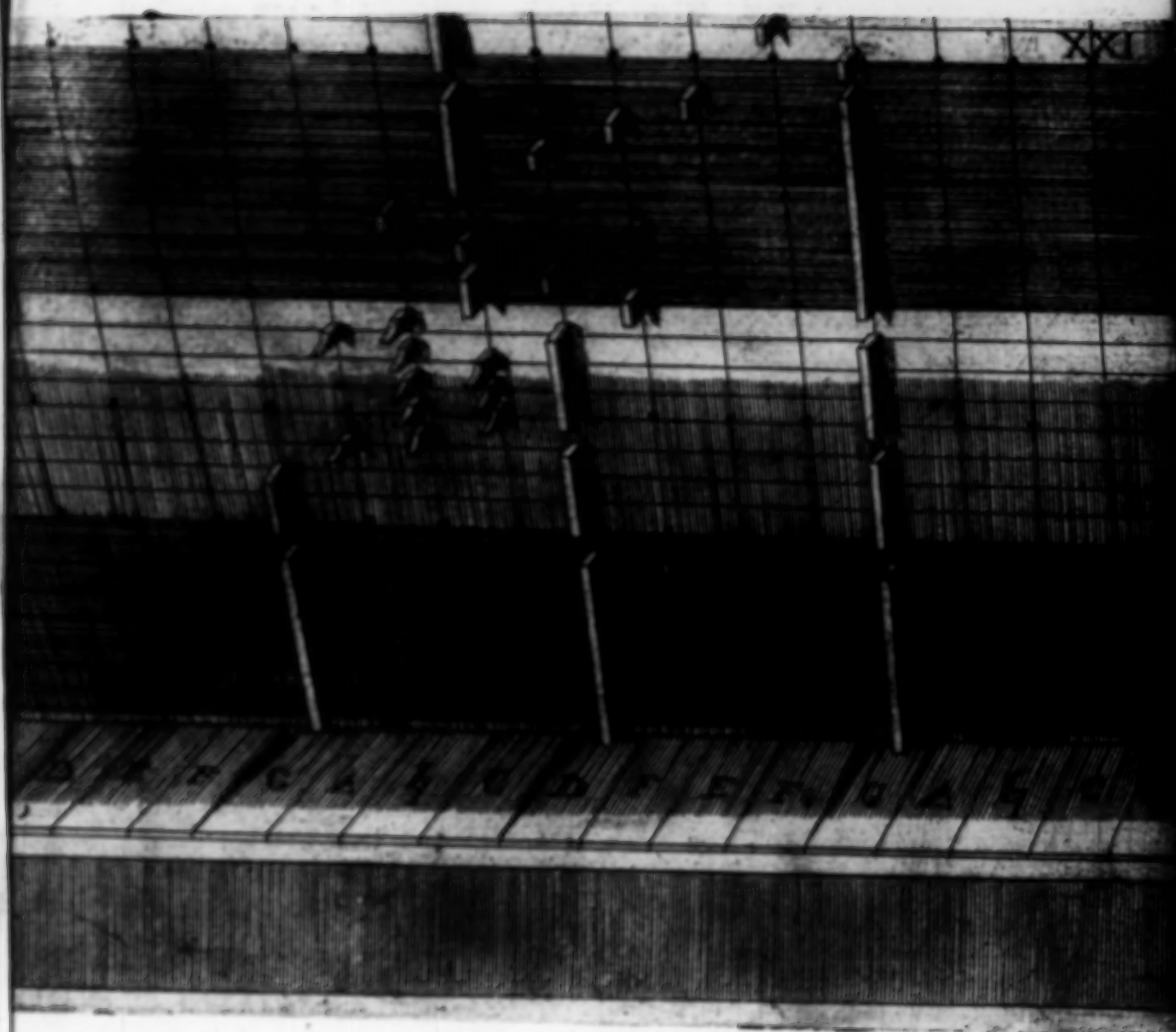


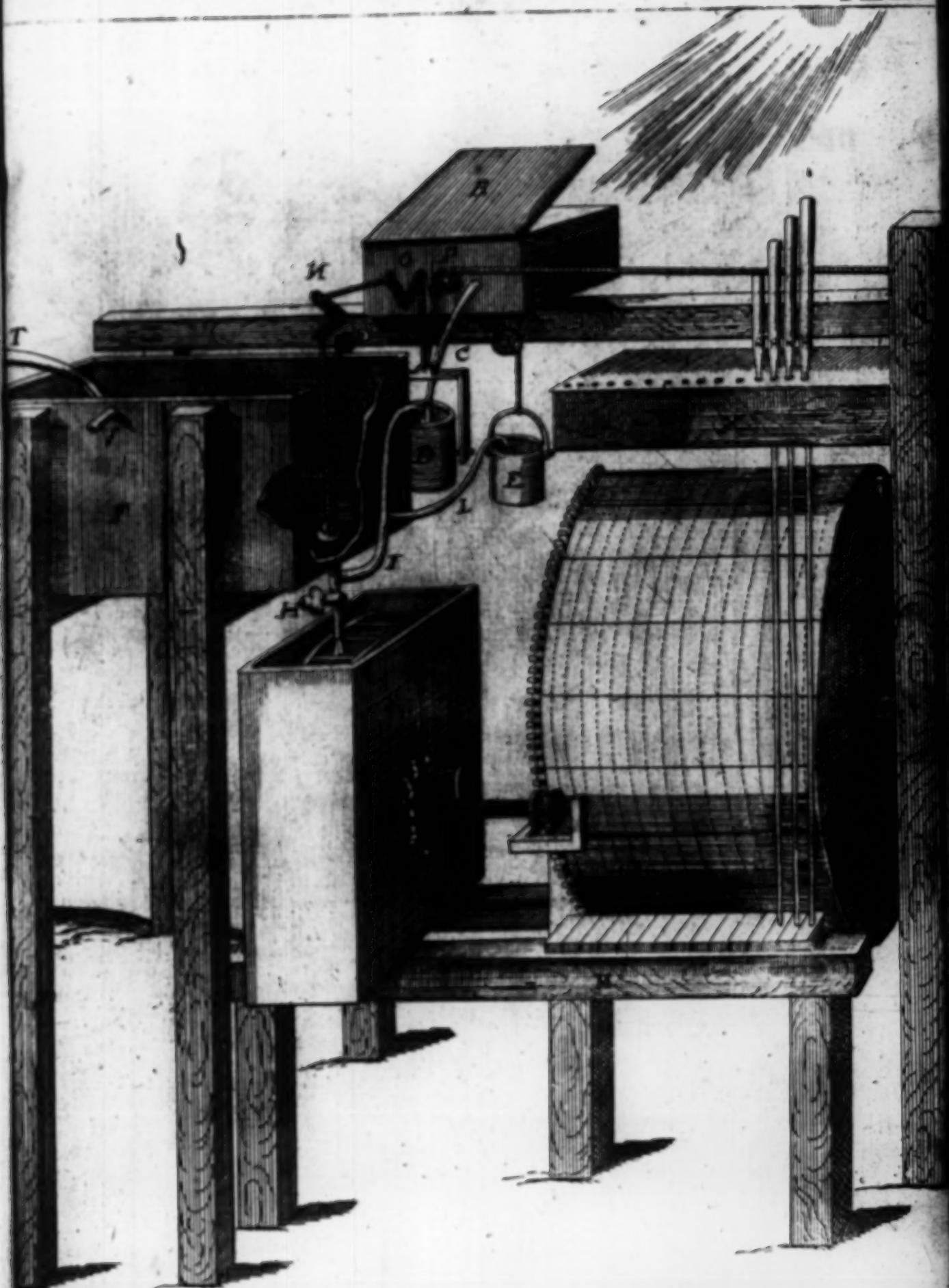
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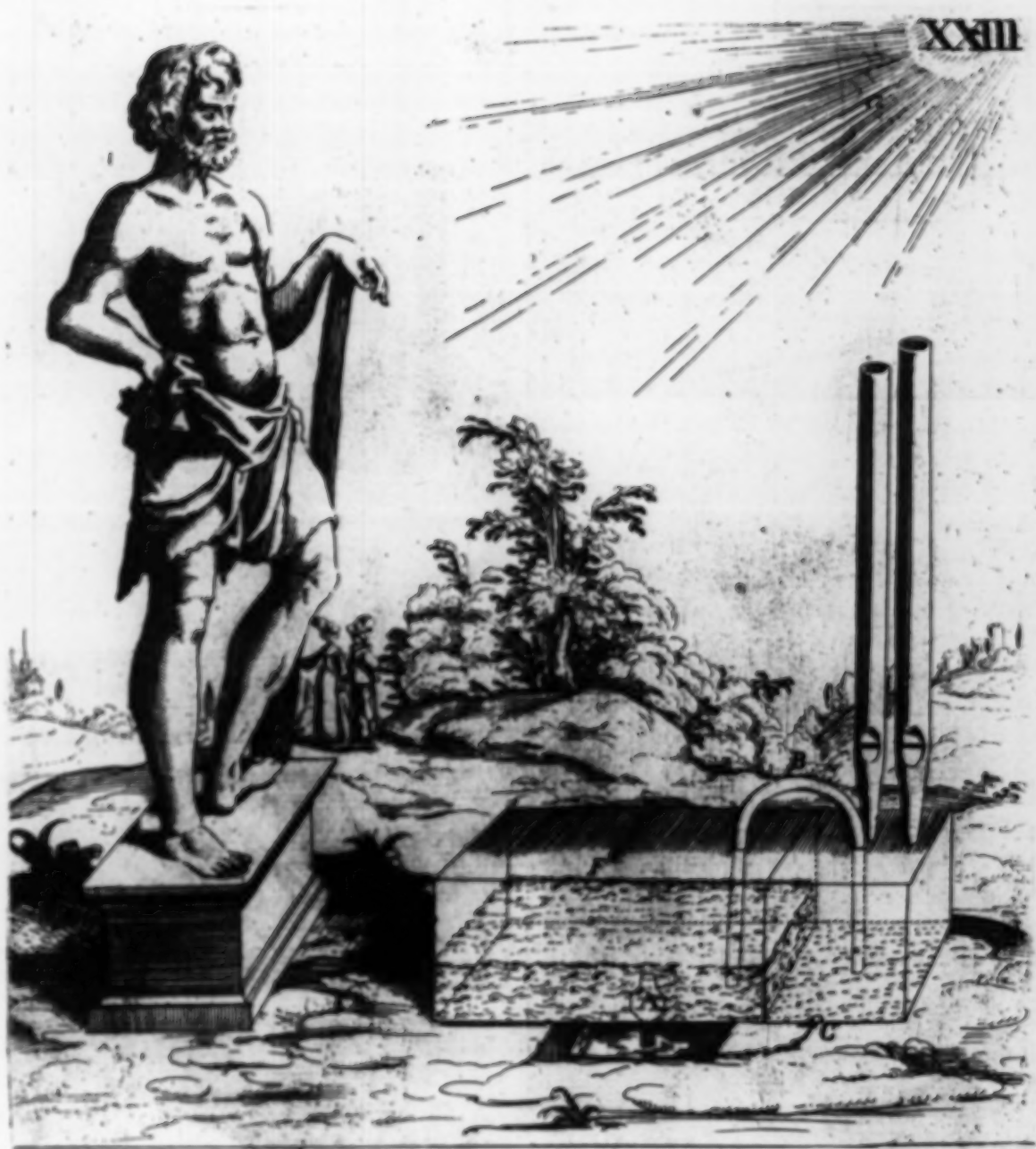


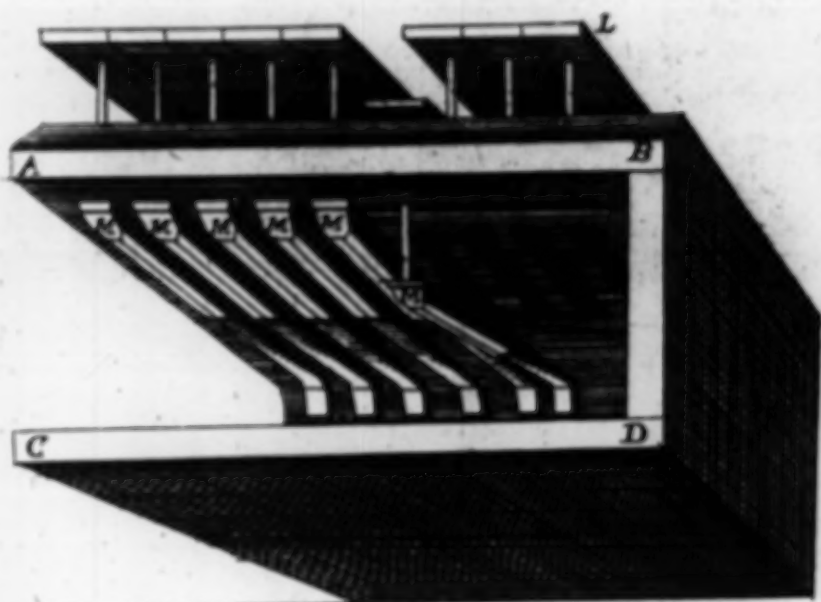
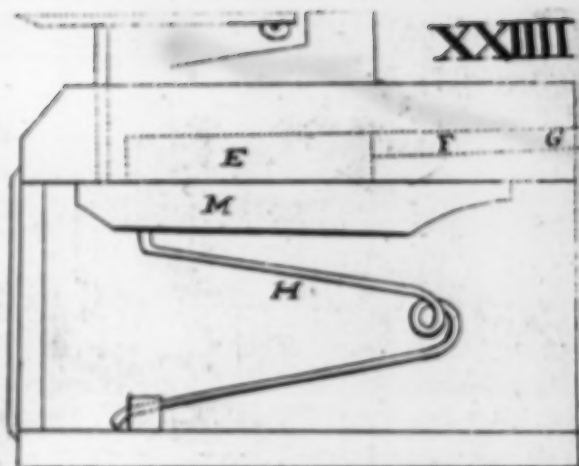
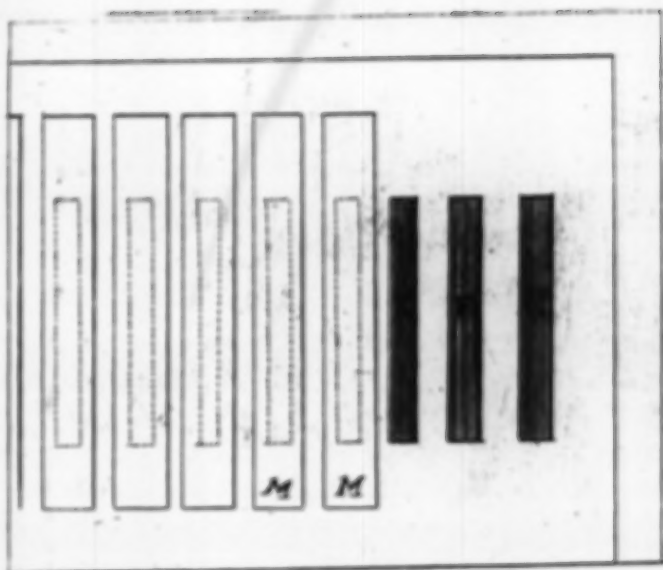
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DEAN

